3. EASTPORT TO CAPE COD

(1) The coasts of Maine, New Hampshire, and part of Massachusetts lie between West Quoddy Head in Maine and Provincetown in Massachusetts. Most of the Maine coast is irregular, rocky, and bold with numerous islands, bays, rivers, and coves. There are numerous fishing villages and towns along the Maine coast which are frequented by tourists during the summer months. The primary deep-draft ports in Maine are at Searsport and Portland. The more densely populated coasts of New Hampshire and Massachusetts have numerous sandy beaches and fewer of the islands, bays, and coves which characterize the Maine coast. Major ports are at Portsmouth, N.H., and Boston, Mass.

(2) The **Gulf of Maine** is the great indentation of the coast between the Canadian Province of Nova Scotia on the northeast and Massachusetts on the southwest. It includes the Bay of Fundy and Massachusetts Bay as subsidiary features. Because of its changeable weather, frequent fogs, and strong tidal currents, this area has a bad reputation among mariners.

(3) From West Quoddy Head to Penobscot Bay the coast is mostly rocky and is indented by numerous large bays and excellent harbors. Among the many islands along this coast are passages that are much used, usually by vessels with less than 12 feet in draft, as they afford anchorage in head winds or thick weather. The many boulders, rocks, and ledges along and off this coast require the closest attention of the navigator, as in many cases they rise abruptly from deep water and soundings do not generally indicate their proximity until it is too late to avoid them. The navigator should also remember that the spring range of tide is 11.2 feet at Rockland, 13 feet at Milbridge, and 20.9 feet at Eastport, and that at high water a vessel may sometimes pass over places on which she would bring up at low water.

(4) Between Penobscot Bay and Cape Elizabeth the coast is rocky and broken by numerous bays and rivers, many of which are excellent harbors. In Muscongus and Casco Bays good channels lead between the islands, affording inside passages that are used by the smaller class of vessels passing along the coast. Extreme caution should be exercised when approaching the bays, sounds, and rivers in this area due to the inset of the flood tidal currents. Particular caution is necessary for small craft crossing Penobscot Bay and the mouths of the Kennebec, Sheepscot, and New Meadows Rivers when the wind is contrary to the current because heavy tide rips are encountered. Great caution is also necessary when standing along this stretch of coast in thick weather due to the numerous dangers which in some places lie nearly 10 miles offshore.

(5) Between Cape Elizabeth and Portsmouth there are fewer harbors and marked indentations. The shore is more thickly settled than farther eastward, and several of the beaches are popular summer resorts. The outlying dangers are well marked and fewer in number.

(6) Southward of Portsmouth the coast is low and mostly sandy, with a few outcropping ledges and outlying dangers, but the northern shore of Cape Ann is high and rocky.

(7) Between Cape Ann and Plymouth the coast is rocky, mostly bold, and has numerous islands, dry rocks, boulders, and covered ledges near the shore, with deep channels between them. The shores of Cape Cod Bay are mostly sandy, with extensive sand shoals extending out well from the shore in many places. Boulders also occur in places in Cape Cod Bay.

(8) **Prominent features.**–The 14-mile coast between West Quoddy Head and Little River presents no special features. From Little River westward to Portland the shore is broken by numerous bays and islands. Grand Manan Island has nearly perpendicular, dark, rocky faces about 200 feet high on its western side.

(9) The numerous radio towers on the peninsula north of Cross Island on the east side of Machias Bay are prominent. The radar domes on Howard Mountain west of Machias Bay can be seen many miles at sea.

(10) Pigeon Hill, on the western side of Pigeon Hill Bay near the head, is 317 feet high. Numerous radio towers are prominent on the eastern side of Prospect Harbor. Schoodic Head, near the south end of Schoodic Peninsula, on the eastern side of the entrance to Frenchman Bay, is 440 feet high. An elevated water tank on Big Moose Island, at the south end of the peninsula, is prominent and reported to be a good radar target.

(11) Cadillac Mountain, the highest on Mount Desert Island, is 1,530 feet high and the most prominent landmark on this part of the coast; near it are other mountains nearly as high. Isle au Haut is 543 feet high near its northern end and is on the eastern side of the entrance to East Penobscot Bay. The Camden Hills (Mount Megunticook, 1,385 feet) are on the western side of Penobscot Bay above the town of Camden. Monhegan Island, 9.3 miles from the mainland, is 165 feet high and is a mark for all vessels bound into Penobscot Bay from westward. Seguin Island, about 2.3 miles off the mouth of the Kennebec River, is about 145 feet high and is a mark for vessels bound into the river or standing along the coast. Observation towers may be seen along the coast west of the Kennebec River to Boston.

(12) Cape Elizabeth, on the southern side of the entrance to Portland Harbor, is about 90 feet high and is marked by a light and an unused light tower. Two tall elevated water tanks, one near the mouth of Saco River and one at Cape Porpoise Harbor, are the most prominent landmarks between Portland and Portsmouth. Mount Agamenticus, 691 feet high and the most prominent land feature between Portland and Cape Ann, is about 4.5 miles inland and 9 miles northward of Portsmouth. A ski lodge on the mountain is reported to be prominent. The Isles of Shoals, lying about 6 miles from the coast and southeastward of Portsmouth Harbor entrance, can be seen a long distance, the large hotel on Star Island and an observation tower on Appledore Island being conspicuous marks. Boon Island Light is about 9 miles northeastward of the Isles of Shoals and about 6.5 miles offshore. Cape Ann is high at its northern end, but its eastern end is comparatively low. The two lighthouses on Thatcher Island, one of which is abandoned, are the most conspicuous marks seen when approaching the cape.

(13) The land southward of Cape Ann is comparatively low, is well settled, and has numerous artificial marks. A strobe-lighted stack at Salem is the most prominent.

(14) In the approaches to Boston Harbor, the most prominent landmarks are a standpipe on Winthrop Head, the control tower of Logan International Airport, the Customhouse tower, several very high office buildings, a tower on Telegraph (Nantasket) Hill, and two lighted radio towers at Nantasket Beach.

(15) In the approaches and on the shores of Cape Cod Bay, the most prominent landmarks are a pointed tower west of Scituate Harbor, the cliffs between Scituate and New Inlet, the Pilgrim Nuclear Power Plant at Rocky Point, a strobe-lighted stack at the

entrance to Cape Cod Canal, a standpipe at Barnstable and Pilgrim Monument at Provincetown.

(16) Approaching Cape Cod from the east or south, the most outstanding marks are Highland Light, Nauset Beach Light, and Chatham Light.

(17) **Disposal Sites** and **Dumping Grounds.**–These areas are rarely mentioned in the Coast Pilot, but are shown on the nautical charts. (See Disposal Sites and Dumping Grounds, chapter 1, and charts for limits.)

(18) **Aids to navigation.**–Lights are numerous, both on the mainland and offshore islands, along the section of coast covered by this Coast Pilot. Large navigational buoys (LNB) are off the entrances to Portland and Boston. Most of the principal light stations and both large navigational buoys are equipped with radiobeacons and fog signals. Many coastal and harbor buoys are equipped with radar reflectors, which greatly increase the range at which the buoys may be detected on the radarscope. Most of the critical dangers are marked.

(19) **Loran.**–Loran C stations provide the mariner with good navigation coverage along this section of the coast.

(20) **Radar** is an important navigation aid in this area, since the shoreline of many of the offshore islands and much of the mainland coast is bold and presents good radar targets. Many of the coastal buoys are equipped with radar reflectors. Radar is of particular importance due to the extended periods of low visibility which are common in this area.

(21) **COLREGS Demarcation Lines.**–Lines have been established to delineate those waters upon which mariners must comply with the International Regulations for Preventing Collisions at Sea, 1972 (72 COLREGS) and those waters upon which mariners must comply with the Inland Navigational Rules Act of 1980 (Inland Rules). The waters inside of the lines are **Inland Rules Waters,** and the waters outside of the lines are **COLREGS Waters.** (See **Part 80,** chapter 2, for specific lines of demarcation.)

(22) **Ports and Waterways Safety.**–(See **Part 160,** chapter 2, for regulations governing vessel operations and requirements for notification of arrivals, departures, hazardous conditions, and certain dangerous cargoes to the Captain of the Port.)

(23) **Regulated Navigation Areas** have been established within the navigable waters of the First Coast Guard District to increase operational safety for towing vessels and tank barges. (See **165.100**, chapter 2, for limit and regulations.)

(24) **Harbor and river entrances.**–The deepwater ports are approached through deep and stable natural channels. The approaches to the major ports are generally wide, but the channels inside the harbor are generally narrow and strong currents develop, making tugs necessary for large vessels. Those with deepest drafts usually enter these ports at or near high water slack.

(25) Most of the small-craft harbors in Maine have entrance channels which are generally deep and stable with numerous submerged, partially submerged, and bare rocks. Most of these dangers are marked and the chart should be followed closely. Along the New Hampshire and Massachusetts coasts, comparatively shallow channels through shifting bars, common at many of the small-craft harbor and river entrances, make caution and current local knowledge advisable for safe entry. Waves break across many of these bars during certain conditions of wind and current; strangers should not attempt to enter under these conditions. On many of the bars the buoys are moved from time to time to mark the shifting channels. The most favorable time to enter most of these harbors is on a rising tide with a smooth sea.

(26) **Traffic Separation Schemes** (Traffic Lanes) have been established in the approaches to Portland, Maine, and Boston, Mass. (See chapters 8 and 11, respectively, for details.)

(27) **Anchorages.**–Between West Quoddy Head and Portland, anchorages are numerous, those most frequently used by coasting vessels being Little River, Starboard Cove, Englishman Bay, Narraguagus Bay, Prospect Harbor, Winter Harbor, Southwest Harbor, Rockland Harbor, Port Clyde, Boothbay Harbor, and Portland Harbor. Southward of Portland the only anchorages available for large vessels are in the harbors of Portsmouth, Gloucester, Salem, Boston, Plymouth, and Provincetown. Other harbors available for small vessels and motorboats are described in the text. Anchorage areas established by Federal Regulations are given in **Part 110,** chapter 2.

(28) **Dangers.**–The Gulf of Maine is a region of ledges and boulders. The ledges rise abruptly from deep water and the boulders ordinarily lie singly or in clusters on an otherwise flat bottom, so that the navigator cannot depend on soundings to avoid them. The depths are so variable that it is quite impossible to determine a vessel's position by soundings alone, but the navigator will find a frequent use of the sounding apparatus of the greatest assistance in approaching both Georges and Browns Bank from southward and eastward because the bottom slope in that area is well defined.

(29) As a measure of safety, vessels should avoid broken ground where abrupt changes are indicated by the chart to depths less than 10 to 12 fathoms. Dangers have been found in places where least depths of as much as 20 fathoms were the only indications found by the survey. It is always safest, therefore, to select from the chart a sailing line which leads in the deepest water and well clear of broken ground.

(30) The principal offshore dangers are Ammen Rock, a part of Cashes Ledge; Georges and Cultivator Shoals, both a part of Georges Bank; and Nantucket Shoals.

(31) **Pipelaying barges.**–With the increased number of pipeline laying operations, operators of all types of vessels should be aware of the dangers of passing close aboard, close ahead, or close astern of a jetbarge or pipelaying barge. Pipelaying barges and jetbarges usually move at 0.5 knot or less and have anchors which extend out about 3,500 to 5,000 feet in all directions and which may be marked by lighted anchor buoys. The exposed pipeline behind the pipelaying barge and the area in the vicinity of anchors are hazardous to navigation and should be avoided. The pipeline and anchor cables also represent a submerged hazard to navigation. It is suggested, if safe navigation permits, for all types of vessels to pass well ahead of the pipelaying barge or well astern of the jetbarge. The pipelaying barge, jetbarge, and attending vessels may be contacted on VHF-FM channel 16 for passage instructions.

(32) **Northern right whales** are the world's most endangered large whale. The population, perhaps fewer than 300 animals, occurs along the east coast of the United States and Canada. Because right whales mate, rest, feed, and nurse their young at the surface, and often do not move out of the way of oncoming ships, they are highly vulnerable to being struck by ships. Ship strikes are one of the known sources of human-related mortality.

(33) *Seasonal occurrence of northern right whales*: In seasons and in areas that right whales may occur, vessel operators should maintain a sharp lookout for right whales. Right whales occur

seasonally in Cape Cod Bay (peak season: January through April), the Great South Channel (peak season: April through June), Stellwagen Bank (peak season: July through September), Jefferys Ledge (peak season: July through mid-December), and the Bay of Fundy (Grand Manan Basin) (peak season: June through December). The first two areas are federally designated critical habitats for right whales. Stellwagen Bank and Jefferys Ledge are located in the federally designated Gerry E. Studds Stellwagen Bank National Marine Sanctuary. The Grand Manan Basin is a Canadian whale conservation area. Seasonal right whale advisories and sighting reports are broadcast periodically for these areas by Coast Guard Broadcast Notice to Mariners, NAVTEX, NOAA Weather Radio, Cape Cod Canal Vessel Traffic Control, the Bay of Fundy Vessel Traffic Control, and other means.

(34) *Description of northern right whale*: The species reaches lengths of 45 to 55 feet and is black in color. The best field identification marks are a broad back with no dorsal fin, irregular bumpy white patches (callosities) on the head, and a distinctive two-column V-Shaped below. They have paddle like flippers nearly as wide as they are long, and a broad, deeply notched tail, (see photographs, and diagram on the following page.)

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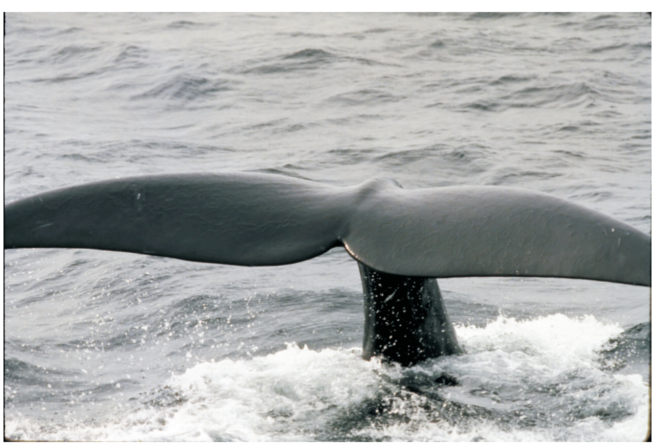
The right whales' unique paddle-shape flippers



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Note the right whales' deeply notched tail fluke

(35) *Early Warning System*: As weather and conditions permit, a dedicated seasonal-program of overflights and vessel surveys (principally in Cape Cod Bay and the Great South Channel) provide whale sighting information to the Coast Guard, NOAA Weather Radio, and others for broadcast purposes. Many right whales however, go undetected.

(36) *Precautions*: The National Marine Fisheries Service's Northeast Implementation Team recommends the following precautionary measures be taken to avoid northern right whales. When transiting right whale critical habitat:

(37) As soon as possible prior to entering right whale critical habitat, check Coast Guard Broadcast Notice to Mariners, NAVTEX, NOAA Weather Radio, Cape Cod Canal Vessel Traffic Control, the Bay of Fundy Vessel Traffic Control, and other sources for recent right whale sighting reports.

(38) To the extent possible, review right whale identification materials and maintain a sharp watch with lookouts familiar with spotting whales.

(39) When planning passage through a right whale critical habitat, attempt to avoid night-time transits, and whenever practical, minimize travel distances through the area. Anticipate delays due to whale sightings.

(40) When the ability to spot whales is reduced (e.g. night, fog, rain, etc.), mariners should bear in mind that reduced speed may minimize the risk of ship strikes. Two of the best documented ship strikes involve a juvenile right whale struck and killed by a vessel proceeding at 15 knots and an unidentified whale, possibly a humpback whale, struck but not re-sighted by the vessel, also moving at 15 knots.

In all coastal and offshore waters along the east coast:

(41) If a right whale sighting is reported within 20-nautical miles of a ship's position, post a lookout familiar with spotting whales.

(42) If a right whale is sighted from the ship, or reported along the intended track of a large vessel, mariners should exercise caution and proceed at a safe speed within a few miles of the sighting location, bearing in mind that reduced speed may minimize the risk of ship strikes.

(43) Do not assume right whales will move out of your way. Right whales, generally slow moving, seldom travel faster than 5-6 knots. Consistent with safe navigation, maneuver around observed right whales or recently reported sighting locations. It is illegal to approach closer than 500-yards of any right whale (See **50 CFR 224.103**, Chapter 2).

(44) Any whale accidentally struck, any dead whale carcass, and any whale observed entangled should be reported immediately to the Coast Guard noting the precise location and time of the accident or sighting. In the event of a strike or sighting, the following information should be provided to the Coast Guard:

(45) location and time of the accident or sighting,

(46) speed of the vessel,

(47) size of the vessel,

(48) water depth,

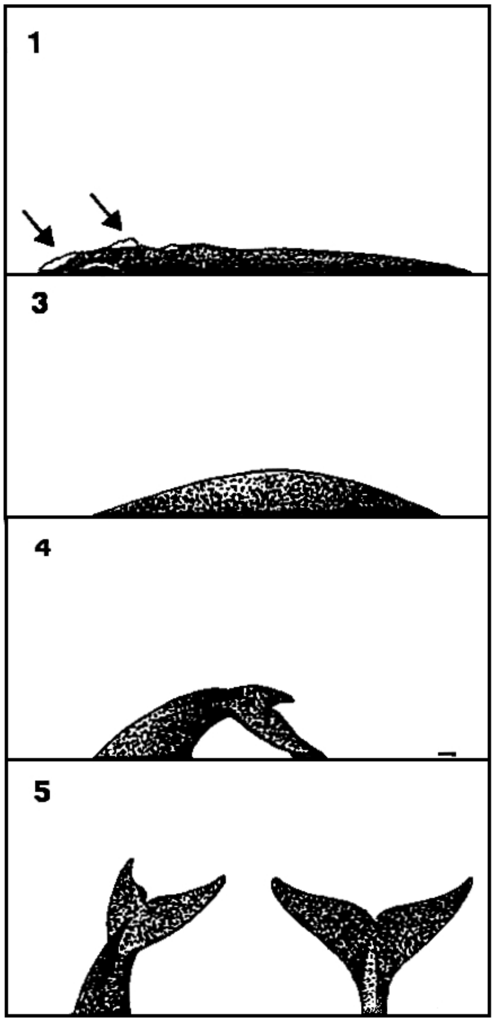
(49) wind speed and direction,

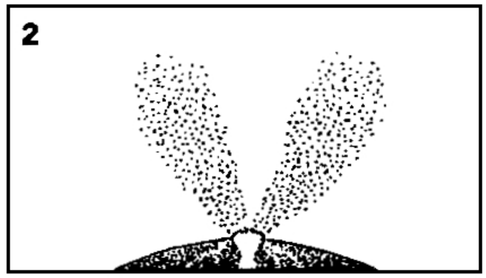
(50) description of the impact,

(51) fate of the animal,

(52) and species and size, if known.

(53) Right whales can occur anywhere along the east coast. Therefore, mariners are urged to exercise prudent seamanship in their efforts to avoid right whales.





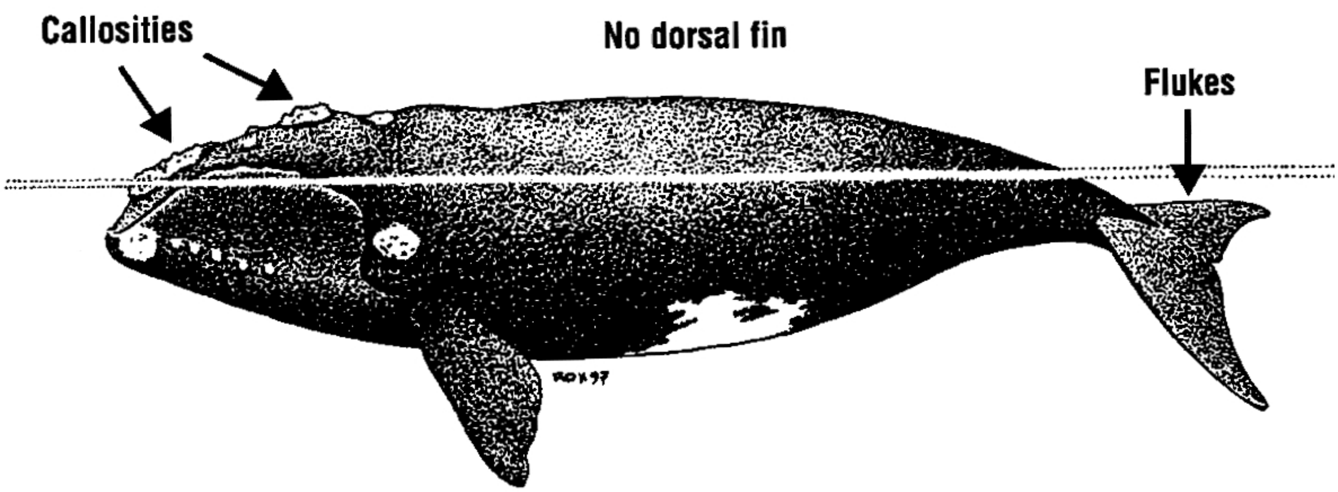
1) Whitish patches of raised and roughened skin (called callosities) on top of the head (see arrows)

2) V-shaped blow easily visible from in front or behind the whale

3) No dorsal fin on the back

4) Tail flukes often lifted vertically when the animal dives

5) All black tail on the top and underside



(54) **Mandatory Ship Reporting Systems (WHALESNORTH and WHALESSOUTH)**, have been established within the area of this Coast Pilot. These Mandatory Ship Reporting (MSR) systems require all vessels, 300 gross tons or greater, to report to the U.S. Coast Guard prior to entering two designated reporting areas off the east coast of the United States. (See **33 CFR 169**, chapter 2, for limits and regulations.) Sovereign immune vessels are exempt from the requirement to report, but are encouraged to participate.

(55) The two reporting systems will operate independently of each other. The system in the northeastern United States will operate year round and the system in the southeastern United States will operate each year from November 15 through April 15. Reporting ships are only required to make reports when entering a reporting area during a single voyage (that is, a voyage in which a ship is in the area). Ships are not required to report when leaving a port in the reporting area nor when exiting the system.

(56) Vessels shall make reports in accordance with the format in IMO Resolution A.858 (20) in accordance with the International Convention for the Safety of Life at Sea 1974 (SOLAS 74). (See **33 CFR 169.135 and 169.140**, chapter 2, for additional information.) Vessels should report via INMARSAT C or via alternate satellite communications to one of the following addresses:

(57) Email: RightWhale.MSR@noaa.gov or Telex: 236737831.

(58) Vessels not equipped with INMARSAT C or Telex should submit reports to the U.S. Coast Guard's Communication Area Master Station Atlantic (CAMSLANT) via narrow band direct printing (SITOR) or HF voice. Vessels equipped only with VHF-FM voice communications should submit reports to the nearest U.S. Coast Guard activity or group.

(59) Example Reports:

(60) **WHALESNORTH** - To: RightWhale.MSR@noaa.gov
(61) WHALESNORTH//
(62) M/487654321//
(63) A/CALYPSO/NRUS//
(64) B/031401Z APR//
(65) E/345//
(66) F/15.5//
(67) H/031410Z APR/4104N/06918W//
(68) I/BOSTON/032345Z APR//
(69) L/WP/4104N/06918W/15.5.//
(70) L/WP/4210N/06952W/15.5//
(71) L/WP/4230N/07006W/15.5//
(72) **WHALESSOUTH** - To: RightWhale.MSR@noaa.gov
(73) WHALESSOUTH//
(74) M/412345678//
(75) A/BEAGLE/NVES//
(76) B/270810Z MAR//
(77) E/250//
(78) F/17.0//
(79) H/270810Z MAR/3030N/08052W//
(80) I/MAYPORT/271215Z MAR//
(81) L/RL/17.0//

(82) **Chart 13009.–Browns Bank** (42°38'N., 65°52'W.) as defined by the 50-fathom curve, is 56 miles long east and west, and has an average width of 15 miles. Near the western end of the bank is a sandy ridge with depths of 16 to 28 fathoms. Between the inner 50-fathom curve of Browns Bank and the coastal bank at the southwestern end of Nova Scotia are depths of 47 to 88 fathoms. Browns Bank is a feeding and mating habitat for endangered northern right whales in late summer and early fall (peak season: July through October).

(83) **Cape Sable** (43°24'N., 65°37'W.), the southern extremity of Nova Scotia, is marked with a light and a fog signal; a racon is at the light. The principal dangers off Cape Sable, Brazil Rock and Blonde Rock, are marked by lighted whistle buoys. Seal Island, 17.5 miles west of Cape Sable, has a light, fog signal, and radiobeacon near the southern end.

(84) **Lurcher Shoal** (43°50'N., 66°30'W.), 13 miles off the west coast of Nova Scotia, has a least depth of 1¼ fathoms. It is the most westerly danger off the coast of Nova Scotia in the approaches to the Bay of Fundy. It is marked by lighted whistle buoys on its southwestern and northeastern ends. Lurcher Shoal West Lighted Whistle Buoy, about 6 miles southwest of the shoal, is equipped with a racon.

(85) **Chart 13260.–Grand Manan Banks** (44°12'N., 67°05'W.), 19 miles southward of Grand Manan Island, have an extent of about 16 miles in a northeast-southwest direction and consist of two sections, **Northeast Bank** and **Southwest Bank,** with a channel 2.5 miles wide between them. The bottom is rocky and the least depth, 19 fathoms, is found on Northeast Bank. The tidal currents on the banks attain a velocity of 1.5 knots at strength, at which time there are extensive tide rips with both flood and ebb. The flood current sets to the north-northeast, and the ebb to the south-southwest. A good check on the position of a vessel may be obtained by soundings on these banks.

(86) Nova Scotia and the Bay of Fundy are described in **Pub. No. 145, Sailing Directions (Enroute), Nova Scotia and the St. Lawrence,** published by the National Imagery and Mapping Agency, Washington, D.C. The Bay of Fundy (Grand Manan Basin) is a feeding and nursery area for endangered northern right whales in the summer and fall (peak season: June through December).

(87) **Jeffreys Bank** (43°22'N., 68°44'W.), with a least found depth of 35 fathoms, lies about 26 miles southward of Matinicus Rock Light. Jefferys Ledge is a feeding area for endangered northern right whales in the summer and late fall (peak season: July through mid-December).

(88) **Platts Bank** (43°12'N., 69°40'W.), has a least found depth of 29 fathoms. Banks with depths of 41 to 50 fathoms are about 5 miles northwestward, and 15 miles eastward of the shoalest part of Platts Bank.

(89) **Cashes Ledge** (42°54'N., 68°57'W.), with depths of 14 fathoms in places, is about 27 miles long. **Ammen Rock,** covered 4¼ fathoms, is near the middle of the ledge. The sea breaks over this rock in heavy weather.

(90) **Fippennies Ledge** (42°47'N., 69°18'W.), with a least known depth of 37 fathoms, lies about 16 miles southwest of Ammen Rock.

(91) **Jeffreys Ledge** extends northeastward from Cape Ann and has general depths of 16 to 30 fathoms and more. The northeastern point of the ledge is 20 miles eastward of Boon Island Light.

(92) **Stellwagen Bank** lies northward of Cape Cod and off the entrance to Massachusetts Bay; depths found over it are 10 to 20 fathoms. Stellwagen Bank is a feeding area for endangered northern right whales in the summer and early fall (peak season: July through September).

(93) **Gerry E. Studds–Stellwagen Bank National Marine Sanctuary**, an area of approximately 638 square nautical miles of Federal marine waters, extends in a southeast-to-northwest direction in extreme southwestern Gulf of Maine, between Cape Ann, MA and the northern end of Cape Cod at the eastern edge of Massachusetts Bay. (See **15 CFR 922**, chapter 2, for rules and regulations.)

(94) **Charts 13200, 13204.–Georges Bank,** east of Cape Cod, is an extensive bank with depths of less than 50 fathoms that extend over 150 miles northeastward from the offshore end of Nantucket Shoals.

(95) In heavy weather the danger area is the oval-shaped top of the bank, which is about 80 miles long in a northeast-southwest direction and 50 miles in maximum width. The bottom in this area is extremely broken and irregular, with a great number of ridges and shoal spots having depths of less than 10 fathoms. Between these shoals are channels of varying widths in which depths of about 20 fathoms may be found. All of this area lies within the 30-fathom curve, and so much of it has depths of less than 20 fathoms that it may practically all be considered to lie within a generalized 20-fathom curve.

(96) On the southeast side of the bank, outside the 20-fathom curve, the water deepens gradually and with such regularity that soundings would be of considerable value in approaching the bank. On the northwest side the water deepens more rapidly.

(97) The bottom is mostly sand, sometimes with shell, and in places pebbles. Bottom samples obtained during surveys are described in a great many places on the charts.

(98) The two principal dangers on Georges Bank are Georges Shoal and Cultivator Shoal, which are near the center of the danger area. Around these shoals the sea breaks in depths of 10 fathoms during heavy weather, and the locality should be avoided by deep-draft vessels.

(99) **Georges Shoal** is a ridge about 16 miles long on which are several shallow depths of 1½ to 3½ fathoms. A submerged obstruction, the remains of an old Texas tower, is on the shoal in 41°41.8'N., 67°46.4'W.

(100) **Cultivator Shoal,** near the western end of Georges Bank, is a ridge nearly 15 miles long, on which depths of 3 to 10 fathoms are found. The 3-fathom spot is near the north end of the shoal. In December 1980, a submerged obstruction was reported about 8.7 miles northwest of the 3-fathom spot in about 41°43'N., 68°23'W.; vessels engaged in bottom operations are advised to exercise caution in the area.

(101) The entire area within the 20-fathom curve has an extremely broken bottom. There are numerous ridges and shoal spots on which depths dangerous to navigation, particularly in heavy weather, may be found. These shoal spots generally have steep sides, and soundings give very little or no indication of their existence. Tide rips and swirls, as well as overfalls, are common in the vicinity of these spots, but are not always visible. They show best with a smooth sea and with the current flowing in certain directions. These disturbances are not usually over the shoalest depths, but are commonly alongside them. Small, detached overfalls may be seen in 20 fathoms of water. The tidal currents are rotary with no period of slack water. The velocity at strength is about 2 knots, and the velocity of the minimum current which occurs about midway between the times of strength is about 1 knot. The flood sets northward, and the ebb southward. The hourly velocities and directions of the tidal current are shown by means of current roses on charts 13200 and 13204.

(102) Between the 50-fathom curve at the eastern end of Georges Bank and the outer 50-fathom curve on Browns Bank to the northeastward is a trough about 25 miles wide.

(103) Ships passing southward and/or westward of the dangerous part of Georges Bank should not approach the bank beyond a least depth of 25 fathoms.

(104) A navigator must bear in mind while in an area of this character that it is impossible for the surveyor, without a vast expenditure of time, to determine and locate all of the shoalest spots on the many dangerous shoals found. Sudden shoaling on such a bank must be considered an indication of possibly dangerous water. This bank has not been wire dragged.

(105) **Nantucket Shoals** is the general name of the numerous different broken shoals which lie southeastward of Nantucket Island and make this one of the most dangerous parts of the coast of the United States for the navigator. These shoals extend 23 miles eastward and 43 miles southeastward from Nantucket Island. They are shifting in nature and the depths vary from 3 and 4 feet on some to 4 and 5 fathoms on others, while slues with depths of 10 fathoms or more lead between those farthest offshore. The easterly edge of the shoals has depths of 3 and 4 fathoms in places.

(106) The currents in the area are strong and erratic, reaching a velocity of 3 to 5 knots around the edges of the shoals. The currents are generally rotary in character, and strongest in a northeast-southwest direction. They are made erratic by the obstruction of the shoals, in some cases being deflected to such an extent as to cause the direction to change 180° from one side of the shoal to the other.

(107) When possible Nantucket Shoals should be avoided entirely by deep-draft vessels (see Area to be Avoided, following) and by light-draft vessels without local knowledge because of the treacherous currents. There are, however, channels through these various shoals which can be negotiated with local knowledge and caution. At slack water in calm weather these shoals are sometimes difficult to see and a vessel is liable to be taken into shoaler water than was intended.

(108) Calm, clear days are few; when the sea is calm it is usually foggy, and when clear, it is usually rough. Also, a considerable amount of hazy weather is to be expected, and this limits visibility.

(109) Should it become necessary to anchor in this area, open sea anchorage may be had anywhere that depths permit. Consideration should be given to the proximity of shoals and to the possibility of dragging due to winds and currents. Generally it has been found best to avoid the deeper channels and, when rougher water is experienced, to anchor in the lee of a shoal which would tend to knock down the heavier swells. A scope of five to one or greater should always be used.

(110) **Area to be avoided.**–Because of the great danger of stranding and for reasons of environmental protection, the International Maritime Organization (IMO) has established an area to be avoided in the area of Nantucket Shoals. All vessels carrying cargoes of oil or hazardous materials and all other vessels of more than 1,000 gross tons should avoid the area bounded by the following points:

(111) 41°16.5'N., 70°12.5'W.,;

(112) 40°43.2'N., 70°00.5'W.;

(113) 40°44.5'N., 69°19.0'W.;
(114) 41°04.5'N., 69°19.0'W.;
(115) 41°23.5'N., 69°31.5'W.; and
(116) 41°23.4'N., 70°02.8'W.

(117) **Phelps Bank,** the southeasternmost part of the Nantucket Shoals, is about 6.5 miles long and 2.5 miles wide. A lighted whistle buoy, marking the entrance to the Boston Harbor Traffic Separation Scheme, is about 12 miles eastward of Phelps Bank. **Asia Rip,** the shoalest point of the bank, covered 5¾ fathoms, is at the southern end. The wreck of the SS OREGON, covered 3¼ fathoms, is 3 miles south-southeastward of Asia Rip in 40°45'N., 69°19'W.; a lighted gong buoy is about 1 mile to the south. The other shoals and rips of Nantucket Shoals are described in **United States Coast Pilot 2, Atlantic Coast, Cape Cod to Sandy Hook.**

(118) Deep-draft vessels should pass southward and eastward of the wreck off Asia Rip, and eastward of the easterly edge of the shoals as defined above. For a distance of 15 miles eastward and southeastward and 17 miles southward from Nantucket Island, the shoals have depths less than 16 feet, and this area should be avoided by all vessels. The tidal currents are strong, and variable in direction, forming extensive rips and broken water over the shoals.

(119) A large wreck area, marked by a lighted gong buoy, is near the southern part of **Fishing Rip.** A wreck and a submerged obstruction are also near the southern part of the rip in about 41°00.0'N., 69°27.0'W. and 41°01.0'N., 69°29.7'W., respectively.

(120) **Nantucket Shoals Lighted Horn Buoy N** (40°30'N., 69°26'W.), replacing Nantucket Shoals Lightship, is a large navigational buoy (LNB) about 51 miles south-southeastward of Nantucket Island. The buoy, 40 feet in diameter, is red with the words U.S. COAST GUARD on the buoy body and the letter N on the daymarks. The buoy shows a light 40 feet above the water and is equipped with a fog signal, a radiobeacon, and a racon.

(121) This buoy is centered inside the traffic separation zone of the traffic lanes of "Eastern Approach Off Ambrose" to the "Traffic Separation Scheme Off New York". (See charts 12300 and 13006).

(122) **Caution.–**Eastbound and westbound vessels should not pass closer than 1.5 miles from Nantucket Shoals Lighted Horn Buoy N; if they pass closer, they are inside the traffic separation zone and are in violation of Rule 10(e) of the International Regulations for Preventing Collisions at Sea 1972 (72 COLREGS).

(123) Vessels crossing the traffic separation scheme shall do so in compliance with Rule 10(c) (72 COLREGS) and should not pass closer than 1 mile from Nantucket Shoals Lighted Horn Buoy N.

(124) (See page T-5 for **Nantucket climatological table.**)

(125) **Great South Channel** is the passage between the easternmost of the Nantucket Shoals and the westernmost shoal spots of Georges Bank. The channel is about 27 miles wide and has depths of 19 fathoms and greater throughout, with lesser depths along the eastern and western edges. The Great South Channel, is a feeding area for endangered northern right whales in spring (peak season: April through June).

(126) **Submarine canyons** are indentations in the edge of the **Continental Shelf,** which is bounded on its seaward side by the 100-fathom curve. They may be traced from depths of 1,000 fathoms or more to the shoaler areas of the shelf. The navigator who has available some means of echo sounding should have in mind the various canyons in this locality. The soundings in crossing them are very characteristic in each case and such soundings may be used to determine the vessel's position with considerable accuracy.

(127) Some of the more important canyons are named on the charts. **Corsair Canyon,** in approximate longitude 66°10'W., on the eastern side of Georges Bank, has a northwesterly trend. On the southern side and toward the western end of Georges Bank, and with a northerly trend, are **Lydonia Canyon,** 67°40'W.; **Gilbert Canyon,** 67°50'W.; **Oceanographer Canyon,** 68°05'W.; and **Welker Canyon,** 68°30'W. Southeastward and southward of Nantucket Shoals, and with a northerly trend, are **Hydrographer Canyon,** 69°00'W.; **Veatch Canyon,** 69°35'W.; and **Atlantis Canyon** (see chart 12300), 70°15'W.

(128) **Wrecks.–**An examination of the record of wrecks along the coast of Maine eastward of Portland shows that wrecks have occurred on practically all of the off-lying islands and rocks between Portland and Machias Bay, most of them in thick weather, either fog or snow. Many of the wrecks could have been prevented if frequent soundings had been taken, or due allowance had been made for the tidal currents setting into or out of bays or rivers.

(129) During thick weather great caution is necessary when approaching the coast, especially eastward of Petit Manan Island, where the tidal currents have considerable velocity. If one of the offshore lights has not been made and the position accurately determined before the fog shuts in, it is advisable to keep well outside until it clears. Between Machias Bay and Seguin Island a landfall will be made in clear weather before the outlying dangers are encountered.

(130) South of Portland the wrecks have occurred most frequently on the prominent headlands or the shoals off them, namely, Cape Elizabeth, Cape Ann, and the north side of Cape Cod, with less frequent wrecks on the less prominent headlands. Numerous wrecks have also occurred on the dangers in the approaches to Boston Harbor, more frequently on the south side from Scituate to Point Allerton. Most of the wrecks have occurred during thick weather.

(131) Between Portland and Boston the most dangerous points for coasting vessels are the dangers off Cape Elizabeth, Boon Island, Isles of Shoals, Cape Ann, and the dangers in the entrance to Boston Harbor. The soundings in the vicinity of Cape Ann are very irregular and cannot be depended upon to fix even approximately the vessel's position.

(132) The numerous strandings on the north end of Cape Cod between Highland Light and Race Point Light have usually occurred to vessels approaching Massachusetts Bay or Cape Cod Bay from southward or eastward in thick weather. Keeping in a greater depth than 20 fathoms will insure giving the eastern side of Cape Cod a berth of 3 miles, and if this depth is followed will lead to Peaked Hill Bar Lighted Whistle Buoy 2PH, northeastward of the end of the cape.

(133) **Lobster pots.**–The inland waters, particularly those from St. Croix River to the vicinity of Portland, contain numerous lobster pots. Small painted wooden buoys of various designs and colors, secured by small lines, float on the surface; in some cases a second buoy, usually an unpainted bottle and hard to see, is attached to the lobster pot. These buoys extend from the shore out to, and in many cases across, the sailing routes. Small yachts and motorboats are cautioned against fouling, which is liable to result in a sprung shaft or propeller.

(134) Fishtraps and fish havens are discussed in chapter 1.

(135) **Danger zones** have been established within the area of this Coast Pilot. (See **Part 334,** chapter 2, for limits and regulations.)

(136) **Drawbridges.–**The general regulations that apply to all drawbridges are given in **117.1 through 117.49,** chapter 2, and the specific regulations that apply only to certain drawbridges are given in **Part 117, Subpart B,** chapter 2. Where these regulations apply, references to them are made in the Coast Pilot under the name of the bridge or the waterway over which the bridge crosses.

(137) The drawbridge opening signals (see **117.15,** chapter 2) have been standardized for most drawbridges within the United States. The opening signals for those few bridges that are nonstandard are given in the specific drawbridge regulations. The specific regulations also address matters such as restricted operating hours and required advance notice for openings.

(138) The mariner should be acquainted with the general and specific regulations for drawbridges over waterways to be transited.

(139) **Routes.**–Approaching or standing along the coast of Maine eastward of Portland.–This section of the coast is dangerous on account of the strong tidal currents, frequent fog, and numerous off-lying dangers. Soundings are of little assistance to locate the position of a vessel, but they should be taken at frequent intervals to prevent too close an approach to dangers.

(140) **Coming from the vicinity of Cape Sable.**–Vessels bound to Machias or ports eastward of it should make Machias Seal Island Light and pass westward of it. If bound to Eastport or Calais, the route through Grand Manan Channel is preferable to passing eastward of Grand Manan Island, because in bad weather an anchorage may be made either at Little River or in Machias Bay.

(141) It is not advisable for a stranger to pass eastward of Machias Seal Island or between it and Grand Manan Island, due to the number of ledges on which the sea breaks in heavy weather, including Bull Rock, a buoyed danger awash at low water.

(142) If bound to ports in Penobscot Bay, vessels should steer so as to make either Mount Desert Light on Mount Desert Rock or Matinicus Rock Light. On a clear day Cadillac Mountain, the highest part of Mount Desert Island, may be sighted before Mount Desert Light, and Isle au Haut may be seen about the same time as Matinicus Rock.

(143) **Coming from the vicinity of Cape Cod or Cape Ann.–**Vessels, both steamers and large tows, bound into Penobscot Bay, including those coming from Boston and Cape Cod Canal, and also those passing eastward of Cape Cod, usually make the lighted whistle buoy off Cape Ann and then shape course for Manana Island Lighted Whistle Buoy 14M and enter through Two Bush or Muscle Ridge Channels. In the winter and in bad weather the small class of vessels follow the coast, sighting the principal lights, and making an anchorage on approach of bad weather. Vessels bound from Cape Cod or Cape Ann to points eastward of Penobscot Bay usually shape the course from Cape Ann to either Monhegan Island or Matinicus Rock Light.

(144) **Standing along the coast.**–In clear weather, vessels stand along the coast close enough to make the lights and to recognize the principal landmarks on shore. In thick weather they aim to make the fog signals or the whistle or bell buoys; these buoys are placed close enough to one another and to the fog signals to be readily followed up by vessels if not set too much off their course by the tidal currents. When running in thick weather a vessel should verify her position as often as possible by the aids, and when approaching a fog signal or buoy should proceed slowly, taking soundings, and if necessary stop until the looked-for aid is found and recognized before she continues for the next aid. Three good harbors that a stranger, standing along the coast in their vicinity, can make in thick weather and enter with ordinary precautions are Machias Bay, Winter Harbor, and Boothbay Harbor.

(145) **Approaching or standing along the coast between Portland and Cape Cod.–Approaching Massachusetts Bay from sea.–**The approach to the coast of Massachusetts north of Cape Cod is through the Gulf of Maine. Nantucket Shoals and Georges Bank, because of their many shoal spots and the strong tidal currents setting over them, are a menace to navigators approaching the coast or standing from Canadian ports to New York. Browns Bank need not be avoided, for its soundings may assist in determining a vessel's approximate position.

(146) The part of Georges Bank lying between latitude 41°05'N., and 42°00'N., and longitude 67°17'W., and 68°35'W. should be avoided. In heavy weather the sea breaks on the spots with 10 fathoms or less, and strong tide rips are encountered. The tide rips do not always indicate shoal water.

(147) Vessels passing south of the dangerous part of Georges Bank should keep in 25 fathoms or more. Approaching this part of the bank from eastward or southward, the water shoals gradually. Approaching from westward, the depths are irregular and the water shoals abruptly in places of 20 fathoms or less. On the north side of Georges Bank, between longitudes 66°00'W., and 68°00'W., the 100-fathom and 50-fathom curves are only a few miles apart, and when approaching the dangerous part of the bank from northward 50 fathoms may be taken as a good depth to avoid the shoals.

(148) Vessels equipped with echo sounding and following the 100-fathom curve along the south side of Georges Bank, can frequently verify their position when crossing the several submarine gorges.

(149) The only known outlying danger in the Gulf of Maine to be avoided by vessels bound to ports in Massachusetts is Ammen Rock, which is a part of Cashes Ledge and is covered 4¼ fathoms.

(150) **Vessels from ports in northern Europe or the British Provinces and bound to ports in the United States north of Cape Cod** approach the coast passing Cape Sable and Georges Bank, between latitudes 42°00'N., and 43°10'N. If bound to Boston, they cross Browns Bank and shape the course for Boston Lighted Horn Buoy B.

(151) The **North Atlantic Lane Routes** are described in **Pub. No. 140, Sailing Directions, North Atlantic Ocean (Planning Guide),** published by the National Imagery and Mapping Agency, Washington, D.C. They are shown on *Pilot Chart No. 16 of the North Atlantic Ocean.

(152) **Vessels approaching the Gulf of Maine from southwest** sometimes endeavor to make the 50-fathom curve on the southern edge of Georges Bank, in

(153) 40°20'N., 68°50'W., then stand 000° on soundings of over 30 and less than 50 fathoms for about 50 miles, and then shape a 323° course, taking care to keep in a greater depth than 20 fathoms until the course is laid to sight Highland Light. This light, Nauset

Beach Light, and the Pilgrim Monument at Provincetown are the most prominent marks on Cape Cod.

(154) Deep-draft vessels coming from Cape Hatteras, Chesapeake Bay, Delaware Bay, or New York make Nantucket Shoals Lighted Horn Buoy N, thence through Great South Channel to the Gulf of Maine.

(155) Vessels of medium draft coming from southward or alongshore may use the Cape Cod Canal or enter the Gulf of Maine through Vineyard and Nantucket Sounds. The controlling depth for these passages is 32 feet. These routes avoid Nantucket Shoals and are followed by vessels in the coasting trade.

(156) **Standing along the coast between Portland and Cape Cod.**–The lights and other aids to navigation are sufficiently numerous to enable a stranger to run either at night or the daytime in clear weather. There are numerous anchorages where a vessel with good ground tackle can ride out any gale. Of these, Provincetown Harbor is the harbor of refuge most frequently used by vessels approaching Massachusetts Bay from seaward. The navigator, when crossing the banks and when approaching the coast, should not neglect to take soundings at frequent intervals, and vessels equipped with the necessary electronic apparatus should make use of radar, loran, and the radiobeacons located along the coast.

(157) **Currents.**–The Tidal Current Tables should be consulted for specific information about times, directions, and velocities of the current at the numerous locations throughout the area. Tidal current charts are available for Boston Harbor.

(158) The current movement is very nearly simultaneous throughout the offshore area of the Gulf of Maine. It is generally rotary in character, the direction of flow changing continuously in a clockwise movement with no period of slack water.

(159) The velocity at strength over Georges Bank varies from about 1 knot to 2 knots. The velocity of the minimum current which occurs midway between the times of strength is usually about one-half the velocity at strength.

(160) Between Georges Bank and Browns Bank the velocity at strength is about 1.5 knots, and there is a like velocity between Browns Bank and Cape Sable Bank.

(161) Off Nova Scotia, outside the 50-fathom curve, the velocity at strength is about 1.5 knots; inside the 50-fathom curve the velocity is between 1.5 and 2.5 knots. The tidal currents offshore from Cape Sable are very uncertain, both in velocity and direction. It is reported that the tidal current on Browns Bank occasionally runs to the northeastward for 15 hours continuously with a velocity of 2 knots, while at other times the set is as strong to the southwestward.

(162) In Grand Manan Channel the average velocity at strength of the current is about 2.5 knots. The currents set approximately parallel to the channel, the flood setting northeastward and the ebb southwestward.

(163) At the entrance to the Bay of Fundy, 5 miles southeastward of Gannet Rock, the flood current has an average velocity at strength of about 2.5 knots and sets 040°. The ebb has an average velocity at strength of about 4 knots and sets 230°.

(164) Along the axis of the Bay of Fundy from Grand Manan Island to Cape Spencer the currents have an average velocity at strength of from 1.5 to 2 knots. The flood sets northeastward, and the ebb southwestward.

(165) Eastward of Mount Desert Island the tidal currents along the coast are stronger and more regular than those farther west. Between Mount Desert Island and Portland there is a westward resultant drift along the coast.

(166) With easterly or southeasterly winds the currents have a tendency to set toward the shore.

(167) At Portland Lighted Horn Buoy P the tidal current is weak, being on the average less than 0.3 knot at time of strength, setting 335° on the flood and 140° on the ebb. Since the tidal current is weak, currents of 1 knot or more occur only with strong winds. The largest velocity likely to occur is about 1.5 knots.

(168) At Boston Lighted Horn Buoy B the tidal current averages about 0.8 knot. The velocity and direction of the current is therefore greatly influenced by the wind. The largest velocity likely to occur is about 1.4 knot.

(169) Over Stellwagen Bank, and in the channel between it and Cape Cod, the flood current sets westward and the ebb northeastward to eastward. The velocity at strength increases from about 0.2 knot at the northern end of the bank to over 1 knot at the southern end.

(170) Along the coast of Maine eastward of Portland the flood sets eastward and has greater velocity than the ebb, which sets westward. In passing from one headland to another it is always necessary to make allowance for the current setting into or out of the bays or rivers, according to the stage of the tide; such allowance frequently amounts to as much as 5°.

(171) **Weather, Atlantic Coast, Eastport to Cape Cod.**–This section presents an overall, seasonal picture of the weather that can be expected in the near and offshore waters along the United States east coast from Eastport, Maine to Cape Cod, Massachusetts as well as coastal and near-coastal sites. Detailed information, particularly concerning navigational weather hazards, can be found in the weather articles in the following chapters.

(172) All weather articles in this volume are the product of the National Oceanographic Data Center (NODC) and the National Climatic Data Center (NCDC). The meteorological and climatological tables are the product of the NCDC. Both centers are entities of the National Environmental Satellite, Data, and Information Service (NESDIS) of the National Oceanic and Atmospheric Administration (NOAA). If further information is needed in relation to the content of the weather articles, meteorological tables or climatological tables, contact the National Climatic Data Center, Attn: Customer Service Division, Federal Building, 151 Patton Avenue, Room 120, Asheville, NC 28801-5001. You may also contact the CSD at 704-271-4994, or fax your request to 704-271-4876.

(173) Climatological tables for coastal locations, meteorological tables for the coastal ocean areas, and a table of mean surface water temperatures and densities relevant to locations discussed within this volume, follow the appendix. The climatological tables are a special extraction from the International Station Meteorological Climate Summary. The ISMCS is a CD-ROM jointly produced by the National Climatic Data Center, Fleet Numerical Meteorology and Oceanography Detachment-Asheville, and the U.S. Air Force Environmental Technical Applications Center, Operating Location–A. The meteorological tables for the ocean areas are compiled from observations made by ships in passage and extracted from the National Climatic Data Center's Tape Deck-1129, Surface Marine Observations. Listed in the appendix are National Weather Service offices and radio stations which transmit weather information.

(174) Marine Weather Services Charts published by the National Weather Service show radio stations that transmit marine weather broadcasts and additional information of interest to mariners. These charts are for sale by the National Ocean Service Distribution Division (N/ACC3). (See appendix for address.)

(175) From winter blizzards to summer thunderstorms, a variety of weather plagues the Gulf of Maine. Tricky currents, large tidal ranges, and numerous shoals complicate matters. The following text describes the weather problems that face the mariner when navigating these waters. The individual chapters contain information on local weather hazards.

(176) **Extratropical Cyclones.**–One of the biggest problems in these waters is the winter storm; the most powerful of these is the "Nor'easter". It generates rough seas, strong winds, and high tides that threaten safety at sea and cause damage in port. These storms do not often come without warning. They are usually well forecasted, whether approaching from the U.S. mainland or from the seas to the south.

(177) Difficulty arises when they develop or deepen explosively off the mid-Atlantic coast. Sometimes called "Hatteras Storms", these lows can grow from small, weak frontal waves to full blown systems in less than 24 hours. Not only can their circulation expand to cover most of the western North Atlantic, but they often accelerate rapidly northeastward. Within the Gulf of Maine, these storms can generate 30-foot waves and hurricane-force winds. Each year more than 40 extratropical systems move across or close to the Gulf of Maine. They average about 2 to 4 per month, but as many as 10 can affect the region in a single month. Most systems are weak, but a few generate gales and rough seas for hundreds of miles, particularly from September through April.

(178) Signals from a distant "Hatteras Storm" include 5- to 10-foot (1.5 to 3 m) swells, with periods of 10 seconds or more, rolling in from the southeast. The most dependable early indicator is falling pressure. A definite weather change is likely if you observe pressure falls exceeding 2 mb every 3 hours. A drop of 5 mb in 3 hours indicates a strong change, while 10 mb in 3 hours warns of an impending extreme event.

(179) As a storm approaches, winds strengthen, clouds thicken and lower, and precipitation begins. Early in the storm's life, wind waves can very quickly become steep. This can make it difficult to reach port, especially when you have to navigate an inlet with treacherous breaking waves. In deeper waters, waves can build to over 20 feet (over 6 m). During winter, the possibility of superstructure icing calls for early action based on the latest forecast and a knowledge of your vessel.

(180) **Cold Fronts.**–These usually approach from west through north. Ahead of the front, winds are usually squally and often blow out of the south through southwest. Cirrus clouds give way to altocumulus or altostratus and nimbostratus, then cumulonimbus. Pressure falls moderately, seas become choppy, and showers, perhaps thunderstorms, occur. With the frontal passage, winds shift rapidly to the west and northwest. Strong gusts and squalls continue. Clearing usually occurs a short distance behind the front as the cold air moves in. Cold fronts can move through the area quite rapidly; their speed varies from about 10 to 20 knots in summer up to 40 knots in winter. From spring through fall, these fronts are often preceded by dense fog.

(181) During the spring and summer when the air ahead of the cold front may be very unstable, a line of thunderstorms, known as a squall line, may develop. These instability lines can form 50 to 300 miles ahead of a fast-moving front. They may even contain tornados or waterspouts and can inflict considerable damage on fishing vessels and small craft.

(182) **Tropical Cyclones.**–This section is condensed from the Hurricane Havens Handbook for the North Atlantic Ocean published by the Naval Environmental Prediction Research Facility at Monterey, CA. While this study concentrates on Boston, the climatology and principles of navigation can be applied to the entire region. The navigation information can be applied to winter storms as well. Data is also incorporated from the Global Tropical/Extratropical Cyclone Climatic Atlas CD-ROM jointly produced by the National Climatic Data Center and the Fleet Numerical Meteorology and Oceanography Detachment-Asheville.

(183) The Gulf of Maine is not in the primary hurricane belt, but some of the most destructive hurricanes have occurred along its shores. For the purposes of this study, any hurricane that approaches within 180 miles is considered a "threat". Of the 105 known hurricanes that threatened Boston from 1842 to 1995, 91 occurred from August through October, with the main threat in September. The hurricane (winds of 64 knots or more) threat has a peak in August and September; 89 hurricanes occurred in those months. Tropical cyclones usually move in from the south or southwest.

(184) Because of the natural protection offered by the shape of the coast from Cape Cod to Cape Hatteras, most recurving storms either make landfall south of Hatteras or pass New England well offshore to the southeast. The majority of storms pass well to the southeast of New England, following the Gulf Stream. Occasionally storms accelerate on a more northerly track, similar to the disastrous hurricane of 1938. That storm advanced rapidly up the east coast, offshore near Hatteras, across central Long Island, into Connecticut, and finally through Vermont. This hurricane's speed of advance reached 52 knots, an advance that would be difficult to prepare for, even with today's sophisticated warning methods. Exceptionally fast-moving storms pose the greatest threat. For example, based on climatology, a September storm located near 27°N., 74°W. would reach Boston in about 3 or 4 days. However, the 1938 hurricane is believed to have traveled this distance in about 30 hours.

(185) Tropical cyclones tend to accelerate as they move north of about 30°N. Speeds of advance range from 25 to 30 knots for those crossing the New England coast, compared to 20 to 25 knots for those passing offshore to the southeast.

(186) During the last 50 years (1946-1995), 43 hurricanes passed within 180 miles of Boston. Sustained winds in the Boston area ranged from about 20 to 75 knots, with gusts up to 87 knots. Winds near the center of these hurricanes ranged from 74 to 117 knots. The main threats from these storms were high winds and seas, heavy rainfall, and rising sea level. In the open Gulf of Maine, seas of 15 to 20 feet (4.6 to 6 m) are likely, particularly with winds from an easterly direction. Inner Boston Harbor is somewhat protected by Deer Island to the north and east and by Long Island to the southeast. Most of the lower inner harbor is exposed to the east, and vessels in this area, unless berthed at well-protected piers, will experience high wind waves. Storm surge during hurricanes has not been a major problem for Boston Harbor area. The highest hurricane-generated surge of 3.9 feet (1.2 m) was measured in the September 1938 hurricane. A 4.9-foot (1.5 m) surge occurred in an extra-tropical storm on November 30, 1945. With a normal tide range of 9 to 10 feet (2.7 to 3 m) , surge heights of 4 feet (1.2 m) are not of great concern unless

they occur at extreme high tide. Then flooding would be considerable. A slow-moving storm with a persistent onshore flow that causes a second high tide while keeping water levels high is the biggest flood threat.

(187) The inner harbor at Boston is considered a hurricane haven if suitable berthing is available. Anchorages in the harbor are unsuitable because of their limited size, surrounding shoals, ledges, and rocks, and variable holding characteristics. The numerous shoals and rocks in the outer harbor make navigation during heavy weather particularly dangerous, so early arrival in the harbor is advantageous. The best anchorages are about 40 miles southeast of Boston Harbor in Cape Cod Bay, within the Hook of the Cape. Small craft should either be removed to positions above projected flood levels or bottom moored in protected areas. There are no recommended small craft mooring facilities in the main harbor. During hurricane Donna in 1960, hundreds of small boats were ripped from their moorings and smashed against rocks or seawalls. Small craft berthed along the western bank of the inner harbor, below the confluence of the Mystic and Chelsea Rivers, appear particularly vulnerable to damage from passing hurricanes.

(188) If evasion at sea is necessary, it is advisable to clear the shoal areas and reach the deep water beyond the continental shelf. The shoal areas should be avoided, because they combine the hazards of limited draft and shallow water wave action in a totally exposed ocean area.

(189) Tropical cyclones that pass near the Bahamas, then stay close to the east coast, pose the greatest threat for a dangerous, completely overwater approach to Boston. These storms are likely to accelerate rapidly northward. They should be evaded either within the confines of Massachusetts Bay or by heading southeastward to clear well to the east. Time is important. From the latitude of South Carolina, a storm usually reaches its closest point of approach to Boston in 15 to 27 hours. Heading southeastward requires crossing in front of a northeastward moving storm; extra caution is advised. Since a majority of these storms accelerate northeastward, vessels must take early action. If the storm becomes one of the unusual northward-accelerating hurricanes that are particularly dangerous to Boston, less time is available to evade, but it is easier to clear well east of the storm. Hurricanes that move ashore along the Atlantic coast usually weaken considerably before reaching the region.

(190) Based on climatology, tropical cyclones north of about 27°N. and east of 70°W. have a low probability of being a destructive threat to Boston. If a major storm in this area does pose a threat, it will most probably move toward the north-northeast. The best evasion route would then lie to the southwest along the coast. If the forecast route is correct, this would keep you in the safe semicircle and allow you to evade the storm that curves to the northeast. Tropical cyclones approaching from the Gulf of Mexico and western Caribbean are not usually a threat to shipping in the Boston area. While passage of such storms within 180 miles of Boston occurs fairly often, their long track over land greatly reduces the wind threat and nearly assures their change to a an extratropical system. They may cause local flooding due to heavy precipitation.

(191) **Waves.**–In March 1984, a 968-mb low off the New Jersey coast generated a 33-foot (10 m) wave at Buoy 44005 (42°53.9'N., 68°56.6'W.) Systems similar to this are partly responsible for the rough seas encountered in the Gulf of Maine from September through April.

(192) Water depth, fetch, and wind duration influence wave heights. Most vulnerable are waters exposed to the flow through the Northeast and Great South Channels. Just east of Massachusetts Bay, seas usually remain below 10 feet (3 m), although a 26-foot (8 m) wave has been observed. A near shore buoy about 7 miles southeast of Cape Elizabeth recorded a 23-foot (7 m) wave in February 1983. The 50-year maximum significant wave heights in the Gulf of Maine range from 30 to 35 feet (9 to 11 m), except near the approaches to Boston Harbor and off southwestern Nova Scotia where they drop to 15 to 25 feet (5 to 8 m). Significant wave height (SWH) is defined as the average height of the highest one-third of the waves of a given wave group.

(193) The table below, from Marine Weather of Western Washington by Kenneth E. Lilly, Jr., Commander, NOAA, shows the relationship between significant wave height and the heights of other waves.

Wave Heights from Significant Wave Heights (SWH)

Most frequent wave heights:	0.5 x SWH
Average wave heights:	0.6 x SWH
Significant wave height (average height of highest 33%)	1.0 x SWH
Height of highest 10% of the waves:	1.3 x SWH
One wave in 1,175 waves:	1.9 x SWH
One Wave in 300,000 waves:	2.5 x SWH

(194) This table can be used to project a range of wave heights that might be expected in deep water. If significant wave heights of 10 feet (3 m) are forecast, then the most frequently observed waves should be in the 5- to 6-foot (1.5 to 1.8 m) range while one wave in 100 should reach 17 feet (5.2 m). A giant or rogue wave might reach 25 feet (7.6 m) in these circumstances. These rogue or "killer" waves occur when the large number of different waves that make up a sea occasionally reinforce each other. This action creates a wave that is much steeper and higher than the surrounding waves. These rogue waves often occur in a stormy sea and are described by mariners who have experienced them as coming out of nowhere and disappearing just as quickly. If significant wave heights are observed at 20 feet (6.1 m), then a rogue wave could reach 50 feet (15.2 m) if the water depth could support it.

(195) Rough sea conditions are usually generated by gales out of the northwest through northeast. Waves greater than 10 feet (3 m) occur about 10 to 15 percent of the time in winter. From fall through spring, wave heights of more than 7 feet (2.1 m) frequently last one day or more; in midwinter they often last 2 days or more.

(196) In addition to coastal storms, cold fronts with rapidly shifting winds can also create dangerous seas.

(197) Steep waves are often more dangerous than high waves with a gentle slope. Waves appear menacing when the ratio of wave height to length reaches about 1/18. They begin to break when this ratio is about 1/10. Steepest waves develop when strong winds first begin to blow or early in a storm's life. The ship no longer rides easily, but is slammed. Steep waves are particularly dangerous to small craft. When wave heights are greater than 5 feet (1.5 m), periods of less than 6 seconds can create problems for boats under 100 feet (under 31 m) long. Waves of 10 feet (3 m) or more with periods of 6 to 10 seconds can affect comfort

in 100- to 200-foot (31 to 61 m) vessels. When wind waves reach 20 feet (6.1 m) , they become hazardous to vessels under 200 feet (61 m) long and provide a rough ride for larger ships. Waves moving into shallow water become steeper and break when the depth is about 1.3 times the wave height. Areas such as Cultivator Shoal and Georges Shoal are dangerous in heavy weather. Wave steepness is also increased by tidal currents, particularly when they oppose the wind.

(198) Swells can create problems for larger vessels. In these waters, about one-half of the waves of 10 feet (3 m) or more are swells from distant storms. They are uncomfortable to ships that roll or pitch in sympathy. Swells with 500- to 1,000-foot (153 to 305 m) wave lengths affect ships of these lengths. When steaming into such swells a resonance is set up until the bow digs into the waves. The resulting pitch will cause more of a power loss than a roll caused by a sea. Swells with wave lengths that range from about three-fourths to twice the ship's length can have this effect. Pitching is heaviest when the ship's speed produces synchronism between the period of encounter and the ship's natural pitching period; this often occurs at or near normal ship speeds.

(199) When running before a following sea, the greatest danger arises when ship speed is equal to that of the waves or when the waves overtake the ship so slowly that an almost static situation is created with the vessel lying on the wave crest. In this latter case, stability is so reduced that a small vessel could capsize. Waves on the quarter or stern can also result in very poor steering quality. As seas move along the vessel from aft to forward, the rudder is less effective and the boat may be slewed across the face of a sea, filling the decks with water as she broaches. She could lose her stability and capsize, particularly if the boat is trimmed by the head.

(200) **Winds.**–Migratory weather systems cause winds that frequently change in strength and direction. Gulf of Maine winds are generally westerly, but often take on a northerly component in winter and a southerly one in summer. Strongest winds are generated by lows and cold fronts in fall and winter and by fronts and thunderstorms during spring and summer. Extreme winds are usually associated with a hurricane or severe northeaster and can reach 125 knots. Sustained winds of 100 knots occur about every 50 years on average; gusts are usually about 30 percent higher.

(201) In the open seas, away from the influence of land, winds are stronger and less complex. From December through March, winds are mainly out of the west through north with gales occurring about 6 to 12 percent of the time. In general, windspeeds increase with distance from the coast. If winds persist for a long time over a long fetch they will generate rough seas. In the Gulf of Maine, winter windspeeds of 15 knots or more persist for more than 12 hours about 70 to 80 percent of the time. However these winds often shift and a new fetch is established. Summer winds are usually out of the south through southwest, and gales are infrequent. During the spring and fall, winds are more variable.

(202) Coastal winds are complex since they are influenced by the topography. Over land speeds are reduced. However, channels, and headlands can redirect the wind and even increase the speed by funneling the wind. In general, winds have southerly components in summer and northerly ones in winter. In sheltered waters near Rockland, Portland, and Brunswick, there are a large percentage of calms, particularly during the morning hours. When the existing circulation is weak and there is a difference between land and water temperatures, a land-sea breeze circulation may be set up. As the land heats faster than the water, a sea breeze is established during the day; this onshore flow may reach 15 knots or more. At night, the land cools more rapidly, often resulting in a weak breeze off the land. In many locations, the sea breeze serves to reinforce the prevailing summer wind.

(203) **Visibilities.**–Fog, precipitation, smoke, and haze all reduce visibilities. Fog is the most restrictive and persistent. It forms when warm, moist air moves across colder water, when very cold air moves over warmer water, or when moist air is cooled to near its dew point by radiation or rainfall. These conditions can be triggered by a number of weather situations.

(204) Prior to the arrival of a cold front, southerly flow of warm air across cool Gulf waters often results in dense fog. Warm or stationary fronts can also bring fog. Rainfall from lows and fronts can create an evaporation fog. Along the coast, radiation fog is common on clear, calm nights, but it usually burns off during the morning. In the spring, coastal fog may occur near the mouths of rivers and streams that are fed by cold snow melt.

(205) As a result of mixing and circulation patterns, water temperatures decrease northeasterly and easterly across the Gulf of Maine. Temperature differences of 5° to 10°F (3° to 6°C) are common. Water temperatures in summer are usually in the 50's and 60's (°F, 10° to 20°C). This is when fog is most frequent. Warm air from the south or southwest can create large patches which may persist for days at a time. Just south of Nova Scotia and in the entrance to the Bay of Fundy, visibilities drop to 0.5 mile or below on an average of 18 days in July. These frequencies fall off dramatically to the southwest.

(206) Areas along the coast, at the heads of bays, and within rivers may be comparatively clear while fog is very thick outside. The frequency of fog over land and water is usually in opposition. Land fog is often most frequent in fall and winter; the maximum of sea fog is in spring and summer. Consequently, figures for fog or poor visibility at inland or sheltered harbors are no guide to conditions at sea or in the approaches.

(207) **Superstructure icing.**–Heavy winter weather can cause ice to collect on ships sailing these waters. At worst, superstructure icing can sink a vessel. When air temperature drops below the freezing point of sea water (about 28.6 °F, -1.9°C), strong winds and rough seas will cause large amounts of sea spray to freeze to the superstructure and parts of the hull that are not frequently washed by the sea. Ice amounts increase rapidly with falling air and sea temperatures and increasing wind speeds. The most dangerous conditions exist when gales last for several days in temperatures of 28°F (-2.2°C) or lower. The ice buildup on a trawler can exceed 5 tons per hour.

(208) A moderate rate of ice accumulation usually occurs when air temperature are less than 29°F (-1.7°C) with winds of 13 knots or more. When air temperatures drop to 16 °F (-8.9°C) or below and winds reach 30 knots or greater, ice collects more rapidly. On a 300- to 500-ton vessel, it would accumulate at more than 4 tons per hour and is called severe. In the Gulf of Maine, the potential for superstructure icing is present from November through April, particularly north of Portsmouth. December, January, and February are the worst months. The potential for moderate icing exists about 10 to 15 percent of the time.

(209) In addition to sea spray, ice is also caused by freezing rain or drizzle and fog in freezing conditions. While these two causes could create enough weight on the rigging to cause it to fall, this is minor in comparison with the freezing spray hazard. Icing on the superstructure elevates the center of gravity, decreasing the metacentric height. It increases the sail area and heeling moment

due to wind action. Its non-uniform distribution changes the trim. It can hamper steerability and lower ship speed. Icing also creates hazardous deck conditions.

(210) Experience and research have helped develop some guidelines for use in weather conditions that cause icing. However, there are no hard and fast rules to guide a skipper through these conditions since no two ships or storms are the same. What follows should just be considered general observations. Common sense dictates that when encountering potential icing situations two prudent courses of action would be to seek shelter from the sea and steer towards warmer water, if feasible. In the Gulf of Maine, warmer water is usually found to the south in winter. Once icing has begun, it is prudent to slow down enough so that little or no spray is taken on board. It is also important to use whatever means are available to keep ice from building up. This includes crewmen using tools or baseball bats to remove ice from the deck and superstructure. In general, heaving to with the bow into the wind and sea as much as possible with the intent of minimizing buildup and varying the course slightly to ensure a symmetrical buildup is a good rule.

(211) The main threat to trawlers is loss of stability. As ice forms, the boat's center of gravity is raised, freeboard is decreased by the added weight and the vessel may eventually be in danger of capsizing. Model experiments indicate that the center of gravity tends to become highest with the wind 30 degrees off the bow and is lowest with the stern to the wind. This is due to spray reaching the superstructure. However good navigational practice dictates that it is usually not recommended to exchange a bow on sea for a following sea unless the safety of the ship is in jeopardy. When ice builds up significantly, it is important to remember that the removal of one ton of ice 50 feet (15.2 m) from the vessel's center of gravity is as effective as removing 10 tons of ice 5 feet (1.5 m) above the center of gravity.

(212) **Immersion Hypothermia.**–Immersion hypothermia is the loss of heat when a body is immersed in water. With few exceptions, humans die if their normal rectal temperature of approximately 99.7°F (37.6°C) drops below 78.6°F (25.9°C). Cardiac arrest is the most common direct cause of death. Except in tropical waters warmer than 68° to 77°F (20° to 25°C), the main threats to life during prolonged immersion are cold, or cold and drowning combined.

(213) Cold lowers body temperature, which in turn slows the heartbeat, lowers the rate of metabolism, and increases the amount of carbon dioxide in the blood. Resulting impaired mental capacity is a major factor in death by hypothermia. Numerous reports from shipwrecks and accidents in cold water indicate that people can become confused and even delirious, further decreasing their chances of survival. The length of time that a human survives in water depends on the water temperature and, to a lesser extent, on a person's behavior. Body type can also cause deviations, since smaller-framed people become hypothermic more rapidly than larger-framed people. Extremely large people may survive almost indefinitely in water near 32 °F (0°C) if they are warmly clothed.

(214) The cooling rate can be slowed by the person's behavior and insulated gear. In a study which closely monitored more than 500 immersions in the waters around Victoria, B.C., temperatures ranged from 39° to 60°F (3.9° to 15.6°C). Using this information, it was reasoned that if the critical heat loss areas could be protected, survival time would increase. The Heat Escape Lessening Posture (HELP) was developed for those in the water alone and the Huddle was developed for small groups. Both require a life preserver. HELP involves holding the upper arm firmly against the sides of the chest, keeping the thighs together, and raising the knees to protect the groin area. In the Huddle, people face each other and keep their bodies as close together as possible. These positions improve survival time in 48°F (8.9°C) water to four hours, approximately two times that of a swimmer and one and one-half times that of a person in the passive position.

(215) Near-drowning victims in cold water (less than 70°F, 21.1°C) show much longer periods of revivability than usual. Keys to a successful revival are immediate cardiopulmonary resuscitation (CPR) and administration of pure oxygen. Don't bother with total rewarming at first. The whole revival process may take hours and require medical help. Don't give up! The U.S. Coast Guard has an easy-to-remember rule of thumb for survival time: 50 percent of people submersed in 50°F (10°C) water, will die within 50 minutes.

(216) **Wind chill and frostbite.**–When the body is warmer than its surroundings, it begins to lose heat. The rate of loss depends on barriers such as clothing and insulation, the speed of air movement, and the air temperature. Heat loss increases dramatically in moving air that is colder than skin temperature (19.4°F, -7.4°C). Even a light wind increases heat loss, while a strong wind can actually lower the body temperature if the rate of loss is greater than the body's heat replacement rate. The wind chill temperature, calculated for a particular wind and temperature combination, represents the temperature that would produce the same heat loss with a wind of about 3 knots, the normal speed of a person walking.

(217) At extremely cold temperatures, wind and temperature effect may account for only two-thirds of the heat loss from the body. For example, in -40°F (-40°C) temperatures about one-third of the heat loss from the body occurs through the lungs in the process of breathing. On the other hand, heat loss is not as great in bright sunlight.

(218) When the skin temperature drops below 50°F (10°C), there is a marked constriction of the blood vessels, leading to vascular stagnation, oxygen want, and some cellular damage. The first indication that something is wrong is a painful tingling. Swelling of varying extent follows, provided freezing has not occurred. Excruciating pain may be felt if the skin temperature is lowered rapidly, but freezing of localized portions of the skin may be painless when the rate of change is slow.

(219) Cold allergy is a term applied to the welts which may occur. Chilblains usually affect the fingers and toes and appear as reddened, warm, itching, swollen patches. Trench foot and immersion foot present essentially the same picture. Both result from exposure to cold and lack of circulation. Wetness can add to the problem, as water and wind soften the tissues and accelerate heat loss. The feet swell, discolor, and frequently blister. Secondary infection is common and gangrene may result. Injuries from the cold may be prevented to a large extent by maintaining natural warmth by using proper footgear and adequate dry clothing, by avoiding cramped positions and constricting clothing, and by active exercise of the hands, legs, and feet.

(220) Frostbite usually begins when the skin temperature falls about 4°F (2°C); to 14°F (8°C). Ice crystals form in the tissues and small blood vessels. Once started, freezing proceeds rapidly and may penetrate deeply. The rate of heat loss determines the rate of freezing, which is accelerated by wind, wetness, extreme

cold, and poor blood circulation. Parts of the body most susceptible to freezing are those with surfaces large in relation to their volume, such as toes, fingers, ears, nose, chin, and cheeks.

(221) **Optical Phenomena.**–Optical phenomena range from electromagnetic displays to intricate geometrical patterns. The aurora and Saint Elmo's fire are electromagnetic displays. Halos, coronas, parhelia, sun pillars, and related effects are optical phenomena associated with the refraction and the diffraction of light through suspended cloud particles; mirages, looming, and twilight phenomena such as the "green flash" are associated with refraction of light through air of varying density. Occasionally, sunlight is refracted simultaneously by cloud suspensions and by dense layers of air, producing complex symmetric patterns of light around the sun.

(222) A mirage is caused by refraction of light rays in a layer of air whose density increases or decreases rapidly near the surface. A marked decrease in air density with increasing altitude causes looming, towering, and superior mirages. Looming occurs when objects appear to rise above their true elevation. Objects below the horizon may actually be brought into view. This effect often leads to a serious underestimation of horizontal distances. Unimpressive landmarks and distant ships may acquire startling characteristics through apparent vertical stretching; this phenomenon is known as towering. A superior mirage is so named because of the appearance of an image above the actual object. Ships have been seen with an inverted image above and an upright image floating above that. Another type, inferior mirages, result from the upward bending of light rays in an unstable air mass. This phenomenon is observed locally whenever a superheated land mass or a wide expanse of open water is overrun by cold air. Sinking below the horizon of relatively close objects may result in an overestimation of horizontal distances.

(223) Occasionally, a complicated vertical temperature distribution may transform hilly coastlines into impressive walls of lofty pinnacles. This phenomenon is known as Fata Morgana.

(224) On clear days, just as the upper rim of the sun disappears below the horizon, green light is sometimes refracted from the solar spectrum. This brief phenomenon is called the green flash.

(225) Floating ice crystals (cirriform clouds, light snow flakes, ice fog, or drifting snow) may cause the refraction of light into a variety of faintly colored arcs and halos. This phenomenon, which may be recognized from the fact that the red band is closest to the light source, includes halos, arcs that open toward or away from the sun, mock images, and various geometrical figures that may be located in various parts of the sky with reference to the sun.

(226) Fogbows, resulting from refraction through suspended water particles, are seen in the region of the sky directly opposite from the sun, or the antisolar point. These bows, although occasionally brilliantly colored, are normally seen as broad white bands with faintly colored borders. Rainbows are also observed.

(227) When atmospheric particles are about equal in size to the wavelength of light, diffraction is likely to occur. Diffractional phenomena frequently show properties similar to those of refraction except for reversal in the spectrum colors, violet being closest to the source of light. The Brocken bow, or glory, appears on clouds or fog banks as a colored ring around the projected shadow of the observers head. Solar and lunar coronas, which are observed only through high clouds, resemble halos except that they may assume increasingly larger diameters as the size of the particles decrease. When the light from the sun or the moon is diffracted by cirrus or cirrostratus, iridescence may sharply delineate the outline of clouds in brilliant green, blue, pink, orange, or purple.

(228) Refraction of sunlight takes place whenever the intervening particles are larger than the wavelength. Sunlight that is reflected from ice crystals is transformed into sun pillars and parhelic circles. When both phenomena occur in combination, they form the remarkable sun cross. Paricelenci circles are observed with moonlight.

(229) The **aurora borealis.** (northern lights) and St. Elmo's fire are two types of electrical phenomena frequently observed in this region. The zone of maximum auroral frequency extends along the periphery of a 20- to 25-degree circle whose center is at the magnetic pole. Auroras are generally associated with moonless nights. An artificial maximum exists in winter because of the longer hours of darkness. No conclusive evidence is available to show that a seasonal variation in the frequency of auroras exists. However, periods of intense sunspot activity are reflected in a maximum occurrence of this electrical phenomenon. Generally auroras may be classified as having either a ray structure (rays, streams, draperies, corona) or a nebulous appearance (homogenous quiet arc, homogenous band, pulsating arcs, pulsating surfaces, diffuse luminous surfaces, and feeble glow). Flaming auroras, which fall in neither category, may be added to this list. Auroras may remain uniformly red, green, or purple, or assume a rapid succession of these colors. Brilliant shifting auroras are invariably accompanied by magnetic storms and electrical interference with communications.

(230) **St. Elmo's fire** is occasionally observed in this area, but because of its faintness it is most commonly observed during the night hours and on dark overcast days. These eerie flickers of bluish light area usually caused by the unusual electrification of snow-filled air, which is most likely when the wind is strong. St. Elmo's fire is restricted to the tips of such objects as ship masts, wind vanes, and airplane wings.

(231) **Dew Point.**–The temperature at which condensation to water droplets occurs is called the dew point. If the dew point is above freezing, condensation will be in the form of water. When the dew point reaches freezing, ice crystals will be deposited on cold surfaces. Knowledge of the dew point, along with cargo temperature and moisture content, is vital for hold ventilation decisions. It is also a parameter used in forecasting fog formation.

(232) **Cargo Care.**–When free air has a dew point temperature higher than the temperature of the surface with which it comes in contact, the air is often cooled sufficiently below its dew point to release moisture. When this happens aboard ship, condensation will take place on relatively cold cargo or on the ship's structure within the hold, where it later drips onto the cargo. Thus, if cargo is stowed in a cool climate and the vessel sails into warmer waters, ventilation of the hold with outside air will likely lead to sweat damage in any cargo sensitive to moisture. Under such conditions, external ventilation should, as a rule, be closed off entirely, unless the cargo generates internal heat, that hazard being greater than sweat damage. In the opposite case, when a vessel is loaded during a warm period and moves into cooler weather, vulnerable cargo should be ventilated.

(233) A safe rule for ventilation directed toward moisture control may be stated as follows: Whenever accurate measurements show the outside air has a dew point below the dew point of the air surrounding the cargo to be protected, such outside air is capable of removing moisture from the hold and the ventilation pro-

cess can be safely started. Whenever the reverse is true, and the outside dew point is higher than the dew point temperature around the cargo, then ventilation will increase the moisture content of the hold and may readily result in sweating within the ship. The above does not take into account possible fumes or gases in the compartment. In such cases discretion must be used.

(234) **Precipitation.**–Although precipitation amounts at sea are not measured, the ship observations reporting precipitation show a maximum in winter and spring, ranging from a high of near 20 percent in January to less than 10 percent in July and August. Some 5 to 10 percent of all observations report snow in January and February.

(235) In the winter when a cyclone passes to the south or southeast, precipitation over the coastal area generally falls as snow. Along the coastal area precipitation amounts are fairly uniformly distributed throughout the year, ranging from about 2.5 to 4.5 inches (64 to 115 mm) per month.

(236) Thunderstorms are not frequent, occurring on an average of less than 20 per year, mainly during June, July, and August. Over the sea their frequency and severity decrease.

(237) **Cloudiness.**–Low clouds covering 0.6 or more of the sky are reported in nearly one-half the vessel observations in the New England offshore area from November through March, while only 20 to 30 percent of the July-October observations report this condition. Overcast conditions of 0.8 to 1.0 sky cover at the coastal stations range from about 55 to 60 percent in winter to 30 to 40 percent in summer.

(238) **Tropical Cyclones.**–Tropical cyclones, although much rarer than the extratropical variety, occasionally move northward in late summer and autumn. The storm centers generally move through the region in a northeastward direction toward and across Nova Scotia or over the adjacent ocean, but some have passed northward onto the southern New England coast. As a rule, these tropical storms are much more violent than the extratropical storms of the same season. Many of them have taken on some characteristics of extratropical cyclones before reaching the area, and are less intense than in more southerly latitudes.

(239) A tropical cyclone is a warm-core, low-pressure system that develops over the warm waters of the tropical oceans, and exhibits a rotary, counterclockwise circulation in the northern hemisphere (clockwise in the southern hemisphere). Although relatively small in area coverage, this storm can attain awesome strength, with winds near its center reaching 175 knots or more. Tropical cyclones occur almost entirely in six rather distinct regions of the world; one of these, the **North Atlantic Region** (West Indies, Caribbean Sea, Gulf of Mexico, and waters off the east coast of the United States), includes the area covered by this Coast Pilot. In this region, tropical cyclones with winds of 34–63 knots are called **tropical storms,** while tropical cyclones with winds greater than 63 knots are called hurricanes. **Hurricanes** are infrequent in comparison with middle- and high-latitude storms, but they have a record of destruction far exceeding that of any other type of storm. Because of their fury, and the fact that they are predominately oceanic, they merit the special attention of all mariners, whether professional or amateur.

(240) Rarely does the mariner who has experienced a fully developed tropical cylcone (hurricane) at sea wish to encounter a second one. He has learned the wisdom of avoiding them if possible. The uninitiated may be misled by the deceptively small size of a tropical cyclone as it appears on a weather map, and by the fine weather experienced only a few hundred miles from the reported center of such a storm. The rapidity with which the weather can deteriorate with approach of the storm, and the violence of the hurricane, are difficult to visualize if they have not been experienced.

(241) As a tropical cyclone moves out of the tropics to higher latitudes, it normally loses energy slowly, expanding in area until it gradually dissipates or acquires the characteristics of extratropical cyclones. At any stage, a tropical cyclone normally loses energy at a much faster rate if it moves over land. As a general rule, tropical cyclones of the North Atlantic Region move with the prevailing winds of the area. In small hurricanes the diameter of the area of destructive winds may not exceed 25 miles while in some of the greatest storms the diameter may be as much as 400 to 500 miles.

(242) At the center is a comparative calm known as the “eye of the storm.” The diameter of this “eye” varies with individual storms and may be as little as 7 miles but is rarely more than 30 miles. The average is 15 to 20 miles. This center is the region of low atmospheric pressure around which winds blow in a more or less circular course, spiraling inward in a counterclockwise direction. Winds at the outer edge of the storm area are light to moderate and gusty, and often increase toward the center to speeds too high for instrument recording. Although the air movement near the center of the hurricane is usually light and fitful, the seas in this area are in most cases very heavy and confused, rendered so by the violent shifting winds which surround it. Furthermore, after the center has passed a vessel, she may expect a sharp renewal of the gales, with winds from a more or less opposite direction. The hurricane may effect an area covering tens of thousands of square miles.

(243) In the North Atlantic, tropical cyclones form over a wide range of ocean between the Cape Verde Islands and the Windward Island, over the western part of the Caribbean Sea, and the Gulf of Mexico. While some may initially move northward, especially those that form southeast of Bermuda, the majority take a westerly to northwesterly course. Of these, some curve gradually northward, either east of or above the larger islands of the West Indies, then turn northeastward or eastward for varying distances from the Atlantic Coast of the United States. Others pass over or to the south of the larger islands and enter the Gulf of Mexico, then curve northward or northeastward and strike some part of the east Gulf Coast. Others may continue westward and strike the west Gulf Coast.

(244) The most common path is curved, the storms moving generally in a westward direction at first, turning later to the northwestward and finally to the northeastward. A considerable number, however, remain in low latitudes and do not turn appreciably to the northward. Freak movements are not uncommon, and there have been storms that described loops, hairpin-curved paths, and other irregular patterns. Movement toward the southeast is rare, and in any case of short duration. The entire Caribbean area, the Gulf of Mexico, the coastal regions bordering these bodies of water, and the Atlantic Coast are subject to these storms during the hurricane season.

(245) Hurricanes develop over the southern portions of the North Atlantic, including the Gulf of Mexico, and Caribbean Sea, **mostly from June through October, infrequently in May and November, and rarely in other months;** the hurricane season reaches its peak in September. An average of nine tropical cyclones form each year (reaching at least tropical storm intensity)

and five of these reach hurricane strength. June and July storms tend to develop in the northwestern Caribbean or Gulf of Mexico while during August there is an increase in number and intensity, and the area of formation extends east of the Lesser Antilles. September storms develop between 50° W. and the Lesser Antilles; in the southern Gulf of Mexico, the western Caribbean, near the Bahamas, and around the Cape Verde Islands. Formation in October shifts primarily to the western Caribbean and off-season storms are widespread with a slight concentration in the southwestern Caribbean.

(246) The average speed of movement of tropical cyclones in the Tropics is about 10 to 15 knots. This speed, however, varies considerably according to the location of the storm, its development, and attendant meteorological conditions. The highest rates of progression usually occur when the storm is moving northward or northeastward in the middle or higher latitudes.

(247) **Locating and tracking tropical cyclones.**–The National Hurricane Center/Tropical Prediction Center located near Miami Florida collects weather observations hourly, depending on the source, from land stations, ships at sea, aircraft and satellite. When a tropical cyclone is located, usually in its early formative stage (a tropical "wave"), it is followed closely. In the North Atlantic, U.S. Navy, Air Force, and NOAA aircraft make frequent flights to the vicinity of such storms to provide information needed for tracking the tropical cyclone and determining its intensity. With the implementation of the NEXt Generation Weather RADar (NEXRAD), coastal radar sites follow the movement of the storm's precipitation area when it is in range. The network provides total coastal coverage from Eastport Maine through Brownsville Texas. Advisories from the Hurricane Center are made available on a 6-hour basis giving information on each storm's location, intensity, and movement. These advisories become more frequent if landfall is imminent. As a further aid, the mariner may obtain weather reports by radio directly from other ships in the vicinity of a tropical cyclone.

(248) **Signs of approach.**–Although radio reports and satellite data, if available, normally prove adequate for locating and avoiding a tropical cyclone, knowledge of the appearance of the sea and sky in the vicinity of such a storm is useful to the mariner. The passage of a hurricane at sea is an experience not soon to be forgotten.

(249) An early indication of the approach of such a storm is the presence of a long swell. In the absence of a tropical cyclone, the crests of swell in the deep waters of the Atlantic pass at the rate of perhaps eight per minute. Swell generated by a tropical cyclone is about twice as long, the crests passing at the rate of perhaps four per minute. Swell may be observed several days before arrival of the storm.

(250) When the storm center is 500 to 1,000 miles away, the barometer usually rises a little, and the skies are relatively clear. Cumulus clouds, if present at all, are few in number, and their vertical development appears suppressed. Nearly perfect tropical blue skies are usually present. The barometer usually appears restless, pumping up and down a few hundredths of an inch. You are in the subsidence sector of the storm; under the influence of the upper-level high pressure system that is acting as the exhaust system for the storm.

(251) As the tropical cyclone comes nearer, a cloud sequence begins which resembles that associated with the approach of a warm front in middle latitudes. Snow-white, fibrous "mare's tails" (cirrus at about 22,000 to 30,000 feet in altitude (6,700 to 9,100 m)) appear when the storm is about 300 to 600 miles away. Usually these seem to converge, more or less, in the direction from which the storm is approaching. This convergence is particularly apparent at about the time of sunrise and sunset.

(252) Shortly after the cirrus appears, but sometimes before, the barometer starts a long, slow fall. At first the fall is so gradual that it only appears to alter somewhat the normal daily cycle (two maximums and two minimums in the Tropics). As the rate of fall increases, the daily pattern is completely lost in the more or less steady fall.

(253) The cirrus becomes more confused and tangled, and then gradually gives way to a continuous veil of cirrostratus. Below this veil, altostratus forms, and then stratocumulus. These clouds gradually become more dense, and as they do so, the weather becomes unsettled. A fine, mistlike rain begins to fall, interrupted from time to time by showers. The barometer has fallen perhaps a tenth of an inch.

(254) As the fall becomes more rapid, the wind increases in gustiness, and its speed becomes greater, reaching a value of perhaps 22 to 40 knots (Beaufort 6-8). On the horizon appears a dark wall of heavy cumulonimbus, the **bar** of the storm. Portions of this heavy cloud become detached from time to time and drift across the sky, accompanied by rain squalls and wind of increasing speed. Between squalls, the cirrostratus can be seen through breaks in the stratocumulus.

(255) As the bar approaches, the barometer falls more rapidly and wind speed increases. The seas, which have been gradually mounting, become tempestuous and, squall lines, one after another, sweep past in ever increasing number and intensity.

(256) With the arrival of the bar, the day becomes very dark, squalls become virtually continuous and the barometer falls precipitously, with a rapid increase in the wind speed. The center may still be 100 to 200 miles away in a hurricane. As the center of the storm comes closer, the ever-stronger wind shrieks through the rigging and about the superstructure of the vessel. As the center approaches, rain falls in torrents. The wind fury increases. The seas become mountainous. The tops of huge waves are blown off to mingle with the rain and fill the air with water. Objects at a short distance are not visible. Even the largest and most seaworthy vessels become virtually unmanageable, and may sustain heavy damage. Less sturdy vessels do not survive. Navigation virtually stops as safety of the vessel becomes the prime consideration. The awesome fury of this condition can only be experienced. Words are inadequate to describe it.

(257) If the eye of the storm passes over the vessel, the winds suddenly drop to a breeze as the wall of the eye passes. The rain stops, and skies clear sufficiently to permit the sun to shine through holes in the comparatively thin cloud cover. Visibility improves. Mountainous seas approach from all sides, apparently in complete confusion. The barometer reaches its lowest point, which may be 1½ or 2 inches below normal in hurricanes. As the wall on the opposite side of the eye arrives, the full fury of the wind strikes as suddenly as it ceased, but from the opposite direction. The sequence of conditions that occurred during approach of the storm is reversed and passes more quickly, as the various parts of the storm are not as wide in the rear of a storm as on its forward side.

(258) **Locating the center of a tropical cyclone.**–If intelligent action is to be taken to avoid the full fury of a tropical cyclone, early determination of its location and direction of travel relative to the vessel is essential. The bulletins and forecasts are an excel-

lent general guide, but they are not infallible and may be sufficiently in error to induce a mariner in a critical position to alter course so as to unwittingly increase the danger of the vessel. Often it is possible, using only those observations made aboard ship, to obtain a sufficiently close approximation to enable the vessel to maneuver to the best advantage.

(259) As previously stated, the presence of an exceptionally long swell is usually the first visible indication of the existence of a tropical cyclone. In deep water it approaches from the general direction of origin (the position of the storm center when the swell was generated). However, in shoaling water this is a less reliable indication because the direction is changed by refraction, the crests being more nearly parallel to the bottom contours.

(260) When the cirrus clouds appear, their point of convergence provides an indication of the direction of the storm center. If the storm is to pass well to one side of the observer, the point of convergence shifts slowly in the direction of storm movement. If the storm center will pass near the observer, this point remains steady. When the bar becomes visible, it appears to rest upon the horizon for several hours. The darkest part of this cloud is in the direction of the storm center. If the storm is to pass to one side, the bar appears to drift slowly along the horizon. If the storm is heading directly toward the observer, the position of the bar remains fixed. Once within the area of the dense, low clouds, one should observe their direction of movement, which is almost exactly along the isobars, with the center of the storm being 90° from the direction of cloud movement (left of direction of movement in the Northern Hemisphere.)

(261) The winds are probably the best guide to the direction of the center of a tropical cyclone. The circulation is cyclonic, but because of the steep pressure gradient near the center, the winds there blow with greater violence and are more nearly circular than in extratropical cyclones.

(262) According to Buys Ballot's law, an observer who faces into the wind has the center of the low pressure on his right (northern hemisphere) and somewhat behind him. If the wind followed circular isobars exactly, the center would be exactly eight points, or 90°, from dead ahead when facing into the wind. However, the track of the wind is usually inclined somewhat toward the center, so that the angle dead ahead varies between perhaps 8 and 12 points (90° to 135°). The inclination varies in different parts of the same storm. It is least in front of the storm, and greatest in the rear, since the actual wind is the vector sum of that due to the pressure gradient and the motion of the storm along the track. A good average is perhaps 10 points in front, and 11 or 12 points in the rear. These values apply when the storm center is still several hundred miles away. Closer to the center, the wind blows more nearly along the isobars, the inclination being reduced by one or two points at the wall of the eye. Since wind direction usually shifts temporarily during a squall, its direction at this time should not be used for determining the position of the center.

(263) When the center is within radar range, it might be located by this equipment. However, since the radar return is predominately from the rain, results can be deceptive, and other indications should not be neglected.

(264) Distance from the storm center is more difficult to determine than direction. Radar is perhaps the best guide. The rate of fall of the barometer is of some help; this is only a rough indication however, for the rate of fall may be quite erratic and will vary somewhat with the depth of the low at the center, the speed of the storm center along its track, and the stage in the life cycle of the storm.

(265) **Maneuvering to avoid the storm center.**–The safest procedure with respect to tropical cyclones is to avoid them. If action is taken sufficiently early, this is simply a matter of setting a course that will take the vessel well to one side of the probable track of the storm, and then continuing to plot the position of the storm center, as given in the weather bulletins, revising the course as needed.

(266) However, such action is not always possible. If one finds himself within the storm area, the proper action to take depends in part upon his position relative to the storm center and its direction of travel. It is customary to divide the circular area of the storm into two parts. In the northern hemisphere, that part to the **right** of the storm track (facing in the direction toward which the storm is moving) is called the **dangerous semicircle.** It is considered dangerous because (1) the actual wind **speed** is greater than that due to the pressure gradient alone, since it is augmented by the forward motion of the storm, and (2) the **direction** of the wind and sea is such as to carry a vessel into the path of the storm (in the forward part of the semicircle). The part to the **left** of the storm track is called the **navigable semicircle.** In this part, the wind is decreased by the forward motion of the storm, and the wind blows vessels away from the storm track (in the forward part). Because of the greater wind speed in the dangerous semicircle, the seas are higher here than in the navigable semicircle.

(267) A plot of successive positions of the storm center should indicate the semicircle in which a vessel is located. However, if this is based upon weather bulletins, it is not a reliable guide because of the lag between the observations upon which the bulletin is based and the time of reception of the bulletin, with the ever present possibility of a change in the direction of motion of the storm. The use of radar eliminates this lag, but the return is not always a true indication of the center. Perhaps the most reliable guide is the wind. Within the cyclonic circulation, a **veering wind** (one changing direction to the right in the northern hemisphere and to the left in the southern hemisphere) indicates a position in the dangerous semicircle, and a **backing wind** (one changing in a direction opposite to a veering wind) indicates a position in the navigable semicircle. However, if a vessel is underway, its motion should be considered. If it is outrunning the storm or pulling rapidly toward one side (which is not difficult during the early stages of a storm, when its speed is low), the opposite effect occurs. This should usually be accompanied by a rise in atmospheric pressure, but if motion of the vessel is nearly along an isobar, this may not be a reliable indication. If in doubt, the safest action is usually to stop long enough to determine definitely the semicircle. The loss in valuable time may be more than offset by the minimizing of the possibility of taking the wrong action and increasing the danger to the vessel. If the wind direction remains steady (for a vessel which has stopped), with increasing speed and falling barometer, the vessel is in or near the path of the storm. If it remains steady with decreasing speed and rising barometer, the vessel is on the storm track, behind the center.

(268) The first action to take if one finds himself within the cyclonic circulation is to determine the position of his vessel with respect to the storm center. **While the vessel can still make considerable way through the water, a course should be selected to take it as far as possible from the center.** If the vessel can move faster than the storm, it is a relatively simple matter to outrun the storm if sea room permits. But when the storm is faster,

the solution is not as simple. In this case, the vessel, if ahead of the storm, will approach nearer to the center. The problem is to select a course that will produce the greatest possible minimum distance. This is best determined by means of a relative movement plot.

(269) As a very general rule, for a vessel in the Northern Hemisphere, safety lies in placing the wind on the starboard bow in the dangerous semicircle and on the starboard quarter in the navigable semicircle. If on the storm track ahead of the storm, the wind should be put about two points on the starboard quarter until the vessel is well within the navigable semicircle, and the rule for that semicircle then followed. With a faster than average vessel, the wind can be brought a little farther aft in each case. However, as the speed of the storm increases along its track, the wind should be brought farther forward. If land interferes with what would otherwise be the best maneuver, the solution should be altered to fit the circumstances. If the speed of the vessel is greater than that of the storm, it is possible for the vessel, if behind the storm, to overtake it. In this case, the only action usually needed is to slow enough to let the storm pull ahead.

(270) In all cases, one should be alert to changes in the direction of movement of the storm center, particularly in the area where the track normally curves toward the pole. If the storm maintains its direction and speed, the ship's course should be maintained as the wind shifts.

(271) If it becomes necessary for a vessel to heave to, the characteristics of the vessel should be considered. A power vessel is concerned primarily with damage by direct action of the sea. A good general rule is to heave to with head to the sea in the dangerous semicircle or stern to the sea in the navigable semicircle. This will result in greatest amount of headway away from the storm center, and least amount of leeway toward it. If a vessel handles better with the sea astern or on the quarter, it may be placed in this position in the navigable semicircle or in the rear half of the dangerous semicircle, but never in the forward half of the dangerous semicircle. It has been reported that when the wind reaches hurricane speed and the seas become confused, some ships ride out the storm best if the engines are stopped, and the vessel is permitted to seek its own position. In this way, it is said, the ship rides with the storm instead of fighting against it.

(272) In a sailing vessel, while attempting to avoid a storm center, one should steer courses as near as possible to those prescribed above for power vessels. However, if it becomes necessary for such a vessel to heave to, the wind is of greater concern than the sea. A good general rule always is to heave to on whichever tack permits the shifting wind to draw aft. In the northern hemisphere this is the starboard tack in the dangerous semicircle and the port tack in the navigable semicircle.

(273) **Practical rules.**–When there are indications of a hurricane, vessels should remain in port or seek one if possible. Changes in barometer and wind should be carefully observed and recorded, and every precaution should be taken to avert damage by striking light spars, strengthening moorings, and if a steamer, preparing steam to assist the moorings. In the ports of the southern States hurricanes are generally accompanied by very high tides, and vessels may be endangered by overriding the wharf where moored if the position is at all exposed.

(274) Vessels in the Straits of Florida may not have sea room to maneuver so as to avoid the storm track, and should try to make a harbor, or to stand out of the straits to obtain sea room. Vessels unable to reach a port and having sea room to maneuver usually observe the previously discussed general rules for avoiding the storm center, which, for power-driven vessels, are summarized as follows:

(275) **Right or dangerous semicircle.**–Bring the wind on the starboard bow (045° relative), hold course and make as much way as possible. If obliged to heave to, do so with head to the sea.

(276) **Left or navigable semicircle.**–Bring the wind on the starboard quarter (135° relative), hold course and make as much way as possible. If obliged to heave to, do so with stern to the sea.

(277) **On storm track, ahead of center.**–Bring the wind two points on the starboard quarter (157½° relative), hold course and make as much way as possible. When well within the navigable semicircle, maneuver as indicated above.

(278) **On storm track, behind center.**–Avoid the center by the best practicable course, keeping in mind the tendency of tropical cyclones to curve northward and eastward.

(279) **Coastal effects.**–The high winds of a hurricane inflict widespread damage when such a storm leaves the ocean and crosses land. Aids to navigation may be blown out of position or destroyed. Craft in harbors, unless they are properly secured, drag anchor or are blown against obstructions. Ashore, trees are blown over, houses are damaged, powerlines are blown down, etc. The greatest damage usually occurs in the dangerous semicircle a short distance from the center, where the strongest winds occur. As the storm continues on across land, its fury subsides faster than it would if it had remained over water.

(280) Along the coast, particularly, greater damage may be inflicted by water than by the wind. There are at least four sources of water damage. First, the unusually high seas generated by the storm winds pound against shore installations and craft in their way. Second, the continued blowing of the wind toward land causes the water level to increase perhaps 3 to 10 feet above its normal level. This **storm tide,** which may begin when the storm center is 500 miles or even farther from the shore, gradually increases until the storm passes. The highest storm tides are caused by a slow-moving hurricane of larger diameter, because both of these effects result in greater duration of wind in the same direction. The effect is greatest in a partly enclosed body of water, such as the Gulf of Mexico, where the concave coastline does not readily permit the escape of water. It is least on small islands, which present little obstruction to the flow of water. Third, the furious winds which blow around the wall of the eye often create a ridge of water called a **storm surge,** which strikes the coast and often inflicts heavy damage. The effect is similar to that of a **Tsunami (seismic sea wave)** caused by an earthquake in the ocean floor. Both of these waves are popularly called **tidal waves.** Storm surges of 20 feet or more have occurred. About 3 or 4 feet of this is due to the decrease of atmosphere pressure, and the rest to winds. Like the damage caused by wind, that due to high seas, the storm tide, and the storm surge is greatest in the dangerous semicircle, near the center. The fourth source of water damage is the heavy rain that accompanies a tropical cyclone. This causes floods that add to the damage caused in other ways.

(281) When proceeding along a shore recently visited by a hurricane, a navigator should remember that time is required to restore aids to navigation which have been blown out of position or destroyed. In some instances the aid may remain but its light, sound apparatus, or radiobeacon may be inoperative. Landmarks may have been damaged or destroyed.

(282) **Ice.**–The extent to which the harbors of Maine are closed to navigation by ice varies greatly in different years. During some winters most of the harbors are open, while in others the only harbors available for anchorages are Quoddy Narrows, Eastport, Little River, Machias Bay (above Avery Rock Light), Mistake Harbor (not much used), Winter Harbor, and Boothbay Harbor. Portland Harbor generally has an open channel in winter, kept so by steamers and tugs. The mouths of the rivers are generally avoided for anchorage in winter and early spring on account of running ice. In the bays and harbors the ice formation is mostly local; beginning at the head, in sheltered places along the shore, it extends outward. During a calm or light winds from northward the local formations rapidly increase, while strong winds break them up and force them as drift ice onto the lee shore. The tidal currents do not prevent the formation of ice or influence its movements in strong winds except in the larger rivers.

(283) In severe winters some of the harbors south of Cape Ann are closed to navigation by ice, and there is more or less drift ice in all the harbors, in Cape Cod Bay, and on Monomoy and Nantucket Shoals. In the principal harbors, steamers and tugs usually keep a channel open. See Ice under the different headings in the text.

(284) **Caution**–Along the New England coast, ice formation and ice movement caused by wind, tides, and currents may result in floating aids to navigation being extinguished, off station, partially submerged, or missing. Icing on buoys can result in misleading color characteristics, missing numerals, and inoperative sound signals. Fixed aids to navigation may be destroyed. Ice formation at radiobeacon stations may reduce the strength and range of radiobeacon signals.

(285) To protect certain light and sound buoys from damage during icing conditions, they may be removed from station or replaced by unlighted buoys without prior notice. Mariners should exercise discretion in using aids to navigation in areas where icing conditions are known to exist.

(286) The **International Ice Patrol (IIP)** was formed in 1914 to patrol the Grand Banks of Newfoundland, to detect icebergs, and to warn mariners of their location. Under the 1974 Safety of Life at Sea (Solas) Convention, 20 member-nations agreed to share the $2.5 million annual cost of operating the patrol. The U.S. Coast Guard conducts the patrol and maintains IIP records.

(287) Today the IIP is coordinated from its operations center at Groton, Connecticut. Its staff presently numbers 13, including Coast Guard and civil service specialists. The usual ice season runs from March through September but can vary. Flying out of the Canadian Forces Base at Gander, Newfoundland, USCG aircraft cover the ice area, a piece of water twice the size of the State of Texas. Its southern boundary is nearly the latitude of New York City and it reaches halfway across the Atlantic with Newfoundland on the northwest and Greenland and Iceland on its north and northeast. A normal flight lasts seven hours and can cover 35,000 square miles.

(288) Once sighted, a berg's location, size, and configuration all are entered into a computer drift model, used until the berg is resighted or melts.

(289) The IIP attempts to locate and track bergs south of the 52nd parallel, and particularly those south of the 48th which may be hazardous to navigation near the Grand Banks. When sighting data is entered into the drift program, predicted positions of bergs are calculated at 0000 and 1200 Gmt.

(290) All shipping is requested to assist in the operation of the IIP by radio reporting all sightings of ice at once to the IIP through any U.S. Coast Guard communications station. Ice sightings reports should include: precise position, size and shape of berg, concentration of ice, and thickness of ice (refer to IIP chart for filing reports). A list of the radio stations broadcasting IIP Bulletins and frequencies and times of broadcasts is published annually in Local Notices to Mariners of the First and Third Coast Guard Districts and in Radio Navigational Aids, Pub. 117, issued by the National Imagery and Mapping Agency.

(291) The IIP operations center can be reached by telephone at (203) 441-2626, or the Coast Guard Operations Center in New York at (212) 668-7878 Vessels carrying Marisat equipment can send messages at their expense to COAST GUARD NY (Telex 126831).

(292) Once daily, a radio facsimile chart of the area depicting ice distribution is broadcast. The IIP seeks comments on its services to mariners, particularly on the effectiveness of the times and frequencies of radio transmissions. Mariners are requested to mail facsimile charts received at sea to:

(293) International Ice Patrol, 1082 Shennecossett Road, Groton, CT 06340-6095. The frequency used, time of receipt, and vessel position at time of receipt should be indicated.

SIZES OF ICEBERGS

SIZE		HEIGHT		LENGTH	
		feet	meters	feet	meters
Growler	(G)	0-3	0-1	0-19	0-5
Small	(S)	4-50	1-15	20-200	6-60
Medium	(M)	51-150	16-45	201-400	61-122
Large	(L)	151+	46+	401+	123+

TYPES OF ICEBERGS

SHAPE		DESCRIPTION
Blocky	(B)	Steep sides with flat top. Very solid. Length-height radio less than 5:1.
Tilted Blocky	(V)	Blocky iceberg which has tilted to present a triangular shape from the side.
Drydock	(K)	Eroded such that a large U-shaped slot is formed with twin columns. Slot extends into or near waterline.
Pinnacled	(P)	Large central spire or pyramid.
Dome	(D)	Large round smooth top. Solid-type iceberg.
Tabular	(T)	Flat-topped iceberg with length-height ratio greater than 5:1.

(294) **Principal ports.**–The ports within the area of this Coast Pilot which have regular deep-draft commercial traffic are Bucksport, Maine; Eastport, Maine; Searsport, Maine; Portland, Maine; Portsmouth, N.H.; Gloucester, Mass.; Salem, Mass.; and Boston, Mass.

(295) **Pilotage** is compulsory for foreign vessels and U.S. vessels under register in the foreign trade as follows:

(296) Maine–Eastport, Cobscook Bay, Pennamaquan River, and Friar Roads when entered through Head Harbor Passage,

Frenchman Bay, Penobscot Bay and River, Kennebec River to Bath, and Portland.

(297) New Hampshire–All ports.

(298) Massachusetts–All ports.

(299) Pilotage is optional for coastwise vessels that have on board a pilot properly licensed by the Federal Government for the waters which the vessel travels.

(300) Arrangements for pilots should be made by the ships' agents at least 24 hours in advance at all of the ports. Detailed information on pilotage procedures is given in the text for the ports concerned.

(301) **Towage.**–Tugs are available at Belfast, Boothbay Harbor, Portland, Portsmouth, and Boston. At a number of other places power fishing boats and launches can be secured for handling smaller vessels and barges. Arrangements for tugs should be made in advance through ships' agents or the pilots. (See the text for the ports concerned as to the availability of tugs.)

(302) **Vessel Arrival Inspections.**–Quarantine, customs, immigration, and agricultural quarantine officials are stationed in most major U.S. ports. (See appendix for addresses.) Vessels subject to such inspections generally make arrangements in advance through ships' agents. Unless otherwise directed, officials usually board vessels at their berths.

(303) **Harbormasters** are appointed for most of the ports. They have charge of the anchorage and berthing of vessels.

(304) **Supplies.**–Boston, Portland, and Portsmouth are the principal ports at which general supplies, provisions, and marine supplies can be obtained. Boston, Portland, Bucksport, Salem, Portsmouth, and Searsport have stocks of fuel oil. Diesel oil is available at Beverly, Boston, Gloucester, Portsmouth, Searsport, Bucksport, Portland, Rockland, and Boothbay Harbor. Yacht and small-boat supplies including gasoline and diesel fuel are available at most of the smaller ports.

(305) **Repairs.**–Major repairs to large vessels can be made at Boston and to a lesser extent at Bath. Portland is equipped to handle above-water hull and engine repairs of deep-draft vessels. Tugs and large fishing vessels can be hauled out at Boston, Gloucester, Stonington, Rockland, and Portland. Smaller vessels, motorboats, and yachts can be hauled out, and ordinary repairs to machinery and hull can be made at most of the smaller ports.

(306) **Small-craft facilities.**–Marine supplies, repair facilities, and other services for small craft are available at all of the major ports, and most of the coastal towns and villages along the coasts of Massachusetts, New Hampshire, and that portion of the Maine coast southwestward of Boothbay Harbor. Northeastward of Boothbay Harbor the coast is less densely populated and the small-craft facilities are usually farther apart and the services rendered are often limited, thereby making careful advance planning prudent. A description of the facilities is given in the geographic text. Some small-craft charts have been published for the area covered by this Coast Pilot that also show marine facilities.

(307) **A vessel of less than 65.6 feet (20 meters) in length or a sailing vessel shall not impede the passage of a vessel that can safely navigate only within a narrow channel or fairway. (Navigation Rules, International-Inland Rule 9(b).)**

(308) **Standard Time.–** The area covered by this Coast Pilot uses eastern standard time (e.s.t.), which is 5 hours slow of Greenwich mean time (G.m.t.). Example: When it is 1000 at Greenwich, it is 0500 along this coast.

(309) **Daylight saving time.–**Throughout the area of this Coast Pilot, clocks are advanced 1 hour on the first Sunday in April and are set back to standard time on the last Sunday in October.

(310) **Legal public holidays.**–New Year's Day, January 1; Martin Luther King, Jr.'s Birthday, third Monday in January; Washington's Birthday, third Monday in February; Memorial Day, last Monday in May; Independence Day, July 4; Labor Day, first Monday in September; Columbus Day, second Monday in October; Veterans Day, November 11; Thanksgiving Day, fourth Thursday in November; and Christmas Day, December 25. The national holidays are observed by employees of the Federal Government and the District of Columbia, and may not be observed by all the States in every case.

(311) In addition, other holidays are observed in the New England States: General Election Day, first Tuesday after first Monday in November, in Maine and New Hampshire; March 17, Evacuation Day, and June 17, Bunker Hill Day, in Boston and Suffolk County, Mass.; Patriot's Day, third Monday in April, in Maine and Massachusetts; Fast Day, fourth Monday in April, in New Hampshire.

(312) **Canadian Hydrographic Service**, Department of Fisheries and Oceans, publishes nautical charts and other related marine publications, including Canadian Sailing Directions. These publications are available from the Canadian Hydrographic Chart Distribution Office and all but the latter are available from the Canadian Communications Group. (See appendix for addresses.)